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Development of a Premier Northern River Fishery: Mesilinka River Pre-fertilization Progress 1992-93

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November 1995

PWFWCP Report No. 82

The Peace/Williston Fish & Wildlife Compensation Program is a cooperative venture of BC Hydro and the provincial fish and wildlife management agencies, supported by funding from BC Hydro. The Program was established to enhance and protect fish and wildlife resources affected by the construction of the W.A.C. Bennett and Peace Canyon dams on the Peace River, and the subsequent creation of the Williston and Dinosaur Reservoirs.

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This report has been approved by the Peace/Williston Fish and Wildlife Compensation Program Fish Technical Committee.

Citation: C. W. Koning, K. I. Ashley, P. A. Slaney, R. W. Land and P. W. Davidson. November 1995. Development of a premier northern river fishery: Mesilinka River pre-fertilization progress 1992-93. Peace/Williston Fish and Wildlife Compensation Program, Report No. 82. 37pp plus appendices.

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ABSTRACT

Koning, C.W., K.I. Ashley, P.A. Slaney, R.W. Land and P.W. Davidson. 1995. Development of a premier northern river fishery: Mesilinka River pre-fertilization progress 1992-93. B.C. Ministry of Environment, Lands and Parks, Fisheries Project Report No. RD46.

The Mesilinka River is one of several large, northern oligotrophic streams inhabited by a migratory and resident fish, and affected by the construction of the Williston Reservoir. Creation of the reservoir, the province's largest, resulted in the flooding of the lowermost and most productive reaches of several streams, thus altering the habitat of fish species, including those valued for sportfishing. The objective of the 1992-93 Mesilinka River study was to assess the response of the fish community to whole-river fertilization, and the river's potential to support a destination sport fishery. The Mesilinka River mainstem (within three reaches, 7 to 8 km each) and nursery tributaries were therefore sampled for water flows, water temperature and chemistry, periphyton, benthic invertebrates and fish species. An external control, the Nation River, was also sampled, but to a lesser degree. The 1992-93 results indicated the Mesilinka River has suitable biophysical characteristics to proceed with fertilization. Mean monthly flows in the Mesilinka River during June, July and August in 1992 were 231, 84 and 30 $m^3 \cdot sec^{-1}$, and in 1993 were 115, 74 and 53 $m^3 \cdot sec^{-1}$, respectively. The ten year average (1982-91) June, July and August mean monthly flows for the Mesilinka River of 181, 108 and 49 $m^3 \cdot sec^{-1}$, respectively. Mean monthly flows in the Nation River in June, My and August, 1992 were 342, 85 and 23 $m^3 \cdot sec^{-1}$, and in 1993 were 182, 106 and 74 $m^3 \cdot sec^{-1}$, respectively. Summer flows in Mesilinka tributaries ranged from a high of 5.8 $m^3 \cdot sec^{-1}$ (Carina Creek), to a low of 0.24 $m^3 \cdot sec^{-1}$ (Fatfish Creek). Wetted widths in the Mesilinka mainstem (August) averaged 35 to 40 m, and in the tributaries (September) 3 to 7 m. Summer water temperatures in the Mesilinka River are at the lower end of a suitable range (10 to 20 °C) to augment salmonid growth, but typical of streams in the Williston Basin. Mean monthly temperatures in the Mesilinka River in July and August 1992-93 ranged from 11.2 to 12.8 °C, respectively. The Nation River was warmer with July and August mean monthly temperatures ranging from 14.4 to 16.8 °C, respectively. Mean monthly water temperatures in Carina Creek, July and August 1993, were warmer (13.6 and 14.4 °C, respectively) than the Mesilinka River, whereas the other tributaries were colder (range 7.4 to 9.1 °C). Soluble reactive phosphorus (SRP) concentrations, June through August, in both the Mesilinka and Nation rivers ranged from less than the detection limit of 1 $ug \cdot L^{-1}$ to 3 $\mu g \cdot L^{-1}$. Nitrate-nitrogen concentrations were mostly < 20 $\mu g \cdot L^{-1}$ (range 5 - 27 $\mu g \cdot L^{-1}$) in 1992-93 Mesilinka River samples, and from < 5 to 7 $\mu g \cdot L^{-1}$ in the lake-headed Nation River. Thus, the Nation River tends to be more nitrogen (N) limited than the Mesilinka River, while both rivers are equally phosphorous (P) limited. Periphyton accrual, as measured by chlorophyll *a* content, was very low, peaking at 6 to 16 $mg \cdot m^{-2}$ in the Mesilinka reaches sampled, and in the Nation River (one reach sampled, peaking at 13 $mg \cdot m^{-2}$), thus confirming their low nutrient status. All Mesilinka tributaries sampled were phosphorus limited, and some were nitrogen limited. Peak chlorophyll *a* in the tributaries ranged from low values similar to the mainstem, to higher values up to 87 $mg \cdot m^{-2}$ (Fatfish Creek) and 115 $mg \cdot m^{-2}$ (Carina Creek). High turbidity and high

suspended sediment levels in the Mesilinka River can persist into mid-July, however, transparencies of >1 m were apparent by late June to early July, thus facilitating the commencement of fertilization in summer.

Underwater counts of fish (expanded to include between-lane fish numbers, and with correction factors applied) in three reaches during the summer of 1992 and 1993 indicate the Mesilinka River has significant numbers of catchable-sized ($\geq$ 20 cm in length) rainbow trout, Arctic grayling, bull trout and mountain whitefish (ranging from 4-31, 9-31, 1-9 and 38-310 fish / km, respectively). Most of the catchable-sized rainbow trout (age 3+ predominate) and Arctic grayling (age 4+ predominate) in both the Mesilinka and Nation rivers, were small and less than 30 cm in length, although sparse numbers of larger rainbow trout were found up to 38 cm (500 g), and larger Arctic grayling up to 40 cm (700 g). Bull trout caught in the Mesilinka River and embayment were up to 81 cm (5.2 kg). Standing crop estimates for Mesilinka River rainbow trout, Arctic grayling, bull trout and mountain whitefish ranged from 0.3 - 2.0, 0.7 - 3.0, 0.4 - 2.5, and 1-10 $kg \cdot ha^{-1}$, respectively. Tributaries of the Mesilinka River provide habitat for juvenile fish, especially for rainbow trout and bull trout. Using mark-recapture techniques, up to 17 and 24 juvenile rainbow trout per 100 lineal m were estimated in Carina and Gopherhole creeks, respectively, and 14 bull trout per 100 lineal m in Control Creek. Catch-per-unit-effort identified Control and Culvert creeks as being important rearing areas for juvenile bull trout, and Gopherhole and Fatfish creeks as important for the rearing of juvenile rainbow trout. In contrast, juvenile Arctic grayling were found primarily in the side-channels of the Mesilinka mainstem. Both a numerical and a growth response by the mainstem fishery to riverine fertilization should become evident, although it is not possible at the current state of knowledge to predict the magnitude. Productivity of juvenile fish should also increase in the fertilized tributaries, and side-channels. Evidence from elsewhere suggests that migratory adult fish will likely be attracted in from the reservoir.

ACKNOWLEDGEMENTS

This project was funded by the Peace/Williston Fish and Wildlife Compensation Program. Field activities in 1992-1993 were carried out by a team including Ken Ashley, Brian Blackman, Don Cadden, Paul Davidson, Tom Gratton, Mark Hunter, Robert Land, Arne Langston, Greg Lord, Allister MacLean and Pat Slaney.

We also acknowledge the following contributions: MELP (Ministry of Environment, Lands and Parks), Fraser Valley Hatchery staff (Dale Larson, Ken Scheer, Morley Rempel, Larry Mitchell, Steve Arnold, Nick Basok, Doug Crawley, Barry Kolodychuk, Charlotte Lawson and Kurt Vinge) spent many hours organizing, cleaning and sorting benthic invertebrate samples; Karin Mathias weighed benthic invertebrate samples; Robert Morton provided software assistance; Theresa Godin developed computer spreadsheets for analysis of underwater fish census data; and Debbie Aird provided office administrative assistance. Biologists Barb Danielson, Lome Fitch, Al Sosiak and Jim Stelfox (Alberta Environmental Protection) supplied fisheries and water quality data pertaining to Rocky Mountain streams in Alberta.

We greatly appreciate the contribution of Finlay Forest Products Ltd. in providing meals and accommodation free-of-charge at their Mesilinka logging camp for project field personnel during the annual August underwater fish census.

Critical review of the draft report was provided by Arne Langston and Andrew Paul. Their comments were of much benefit.

Finally, we especially thank Dr. Art Tautz, Manager, Fisheries Research and Development Section, for his continued enthusiasm and support of our endeavours in stream fertilization.

105-02525/

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INTRODUCTION

Indices of nutrients, have been reported as positively correlated with salmonid abundance in streams (McFadden and Cooper 1962, Egglishaw 1968). Food abundance, as a function of nutrient availability, operates through territory size as a determinant factor affecting the abundance and growth of salmonids, and thus the carrying capacity of streams (Warren et al. 1964; Chapman 1966; Slaney and Northcote 1974; Dill et al. 1981; Wilzbach 1985). Additions of inorganic nutrients to oligotrophic streams increases periphyton production (Stockner and Shortreed 1978; Peterson et al. 1985; Perrin et al. 1987) at the base of the food chain, and thereby stimulates insect growth and abundance (Huntsman 1948; Milbrink and Holmgren 1981; Peterson et al. 1985; Johnston et al. 1990; Mundie et al. 1991; Quamme 1994), and growth of fish species such as steelhead trout *(Oncorhynchus mykiss),* coho salmon *(Oncorhynchus kisutch)* (Slaney et al. 1986; Johnston et al. 1990), and Arctic grayling *(Thymallus arcticus',* Deegan and Peterson 1992). Fertilization of salmon nursery lakes to enhance commercially important sockeye salmon routinely occurs in British Columbia and Alaska (e.g., Hyatt and Stockner 1985). Thus, controlled seasonal increases in nutrient concentrations (which can also be easily reversed) should, in theory, be beneficial to fish production in oligotrophic streams and rivers.

Research has been conducted on stream fertilization for over a decade on Vancouver Island, British Columbia, firstly at the Keogh River during the 1980's (Johnston et al. 1990), and more recently at the Salmon River (Slaney and Ward 1993, Slaney et al. 1994a). Primary objectives were to determine the effect of nutrient additions on the growth and abundance of anadromous salmonids in oligotrophic streams, to determine if controlled seasonal enrichments are a cost-effective rehabilitation technique, and to evaluate the technique to provide mitigation of logging impacts on, for example, overwinter survival of juvenile steelhead. Fertilization of the Keogh and Salmon rivers resulted in 2 to 3-fold increases in the average weight of juvenile steelhead trout after only 2 to 3 months of fertilization (Slaney et al. 1986; Johnston et al. 1990; Slaney and Ward 1993).

Periphyton bioassays and whole-river fertilization at the upper Nechako River (northern British Columbia), supported by the Nechako Fisheries Conservation Program, demonstrated that low level fertilization is feasible and relatively inexpensive in a large lake-headed river in central B.C. Periphyton responses were detected 50 km downstream of a single fertilizer input site, illustrating that nutrient cycling or spiralling can occur over extended distances in large streams (Slaney et al. 1994). Subsequent insect bioassays in 1990 confirmed there was a strong benthic insect response to the nutrient additions (Perrin and Richardson, in prep.). Fertilization was planned as an annual mitigation technique to offset impacts on salmonids from Alcan's

proposed Kemano Completion Project (hydro-electric project), prior to its' cancellation in 1995.

A few trophy-size resident trout fisheries have been historically associated with cultural enrichment, for example, the Cowichan River (Vancouver Island), and Crowsnest and Bow rivers (Alberta), suggesting that inorganic nutrients from treated sewage effluent can be beneficial if discharged to the river in a controlled manner. The response of resident salmonids is likely more evident (than with anadromous fish) because they remain in the stream for several more years, especially among species with some longevity.

Establishment of the Williston Reservoir in 1968-1972 flooded substantial portions of the Peace, Parsnip and Finlay rivers, as well as the lower portion of many large and small tributaries, including the Mesilinka and Nation rivers (Barrett and Halsey 1985). Riverine habitats (such as groundwater channels, off-channel ponds, oxbows and deep pools) utilized by salmonids, Arctic grayling and mountain whitefish were reduced substantially (Bruce and Starr 1985). Thus, the present Mesilinka project can be considered a mitigation option, to compensate for loss of fish populations in the lower, flooded Mesilinka and Omineca rivers.

The objective of the 1992-93 Mesilinka River study was to collect biophysical data on the river, to assess its potential for response to whole-river fertilization. The response of the fish population to fertilization may initially lag in the Mesilinka, as the cooler temperature regime of the Mesilinka (<12 °C mean monthly summer temperatures) can be expected to moderate both the response and potential benefits to a destination fishery. In trough experiments, insect emergence did not increase as a result of fertilization until 2-3 years later (Mundie et al. 1991). Thus, until there is a "carryover" of insects from the fall of one year to the next spring, benefits to fish growth in July to September may be limited. A portion of the phosphorus will likely pool at depth in river sediments which will subsequently be available for release gradually throughout the year, but there is limited information on nutrient spiral-pathways in smaller (Newbold et al. 1981), and larger streams (Slaney et al. 1994a). On the positive side, with only a six week growth window in the Kuparuk River in northern Alaska, Arctic grayling still increased in mean weight by 1.5 to 2.4 times as a result of stream fertilization (Deegan and Peterson 1992).

BACKGROUND

Study Area

Mesilinka River

The Mesilinka River is a large northern river (watershed area, 3285 km^2) located approximately 280 km north of the city of Prince George, B.C.. The headwaters originate in the Omineca mountain range and the river flows for a distance of approximately 120 km prior to emptying into B.C's largest freshwater body, Williston Reservoir (Fig. 1). Williston Reservoir (watershed area, 70,860 km^2; reservoir surface area, 1775 km^2) was formed behind the W.A.C. Bennett Dam during the 1960's to provide hydroelectric energy, and is part of the Peace-Slave-Mackenzie River system which ultimately flows north and discharges into the Arctic Ocean.

Flows of the Mesilinka River are relatively high in spring to early summer due to melting snow pack and spring rains. Mean spring to summer flows for the 10 year period, 1982-91, were 74, 180, 108, 49 and 35 $m^3 \cdot sec^{-1}$ during May, June, July, August and September, respectively, according to Water Survey of Canada (WSC) flow data. Minimum flows of 6 to 8 $m^3 \cdot sec^{-1}$ occur in February and March. The temperature regime of the Mesilinka River is typical of many large Williston Reservoir streams, averaging 10 - 13 °C (mean monthly) in summer. Water temperatures increase gradually in the lower river, as solar heating elevates the temperature in the river.

Concentrations of soluble reactive phosphorous (SRP) and total dissolved phosphorous (TDP) are extremely low; typically below detectable limits of <1 $\mu g \cdot L^{-1}$ and <3 $\mu g \cdot L^{-1}$, respectively, indicating that the river and its main tributaries are highly oligotrophic (data on file from samples from 1991). Nitrate-nitrogen ranges from 5 to as high as 40 g·L-1 during the open-water season. Nitrate-nitrogen values below 20 $\mu g \cdot L^{-1}$ are considered to be algal growth limiting (Slaney et al. 1994). Periphyton accrual is very low (peaking at 10 - 16 $mg \cdot m^{-2}$), which corresponds with low insect abundance in stream substrates. Underwater inspection of the substrate of several riffles in the mainstem confirm that the periphyton and insect communities are poorly developed, and of low biomass. The low nutrient concentrations are typical of a northern interior watershed of shallow soils overlying bedrock, and without returning salmon or kokanee to provide an external source of marine or reservoir derived nutrients.

Forests within the watershed include valley-bottom old growth sub-boreal spruce *(Picea* sp), boreal white spruce *(Picea glauca)* and black spruce *(Picea mariana)*, and mid-elevation old growth Engelmann spruce *(Picea engelmannii)* - subalpine fir *(Abies lasiocarpa)*. Logging has

been active in the watershed since the early 1970's, with harvesting primarily of white spruce, lodgepole pine *(Pinus contorta)* and subalpine fir (J. Thomas, Chief Forester, Finlay Forest Industries Inc., Mackenzie, B.C., pers. comm.). Most activity has occurred in the lower watershed where approximately 30-35 % of the area has been logged. In the upper portion of the Mesilinka watershed only 5 % has been logged (J. Thomas, Chief Forester, Finlay Forest Industries Inc., Mackenzie, B.C., pers. comm.). Mature white and black spruce, aspen *(Populus tremuloides)*, balsam poplar *(Populus balsamifera)*, willow species *(Salix* sp), and red alder *(Alnus rubra)* are the dominant trees and shrubs in the riparian zone.

Logging impacts reported elsewhere in the province, include removal of riparian vegetation and increased stream siltation. The extent of these impacts in the Mesilinka watershed are undocumented, but past logging to the streambank of some of the tributaries and within sections of the mainstem are detrimental to fish habitat. Despite the logging, exceptional viewscapes abound within the Mesilinka watershed.

Wild rainbow trout *(Oncorhynchus mykiss)*, Arctic grayling *(Thymallus arcticus)* and mountain whitefish *(Prosopium williamsoni)* populations inhabit the river, as well as smaller populations of bull trout *(Salvelinus confluentus)*. Aside from bull trout, adult salmonid fish are small in size ($\leq$ 30 cm on average). Salmonid spawning and rearing habitat is found primarily in tributaries of the Mesilinka River and these include Control, Culvert (also called Upper Culvert Creek, in 1992), Carina, Gopherhole, Tutizzi (also known as Tutizika) and Fatfish creeks. There are no known fish barriers to salmonid fishes on the mainstem. Other species found either in the mainstem or tributaries include burbot *(Lota lota)*, sucker species *(Catostomus* sp.), sculpin species *(Cottus* sp.), and various Cyprinids including northern squawfish *(Ptychocheilus oregonensis)*.

Fish habitat in the mid to lower Mesilinka River consists of riffles, runs, glides and pools. Field work carried out in September, 1990 found the Mesilinka River, in two sections (1400 m upper and 1700 m lower sections, near km 20) to be 71 and 51 % glide, 13 and 23 % pool, 8 and 19 % riffle and 8 and 7 % run, respectively. Mean wetted widths were 36.8 and 40.1 m; mean channel widths 70.4 and 73.2 m. Mean maximum pool depths were 4.0 and 4.4 m and mean riffle depth, 0.60 and 0.55 m, respectively. Stream slope ranged from 0.2 - 3 % (Langston and Blackman 1993).

Based on a mean monthly (July to mid-October) temperature of 12, 13, 9 and 6 °C in the lower river, trout (12) sampled in 1990 may have been growing at near-maximum during their 1st and 2nd year (age 1-2 or 2-3) in the river, and it is not until age 4 and 5 that large potential gains in size from enrichment could be realized. Prediction of size-at-age using ambient temperatures and near-maximum ration were made with a simple hatchery model (Iwama and Tautz 1981) with twenty percent added for non-fertilized months. The model suggests that size would peak at 900 g (trout) and 1400 g (grayling) for resident fish at age 6 and 7, respectively.

Grayling grow at optimum rates at lower temperatures than rainbow (eg. Kindschi and Barrows 1990), and therefore temperature was elevated 1.5 °C to compensate in the salmonid model.

The Mesilinka River flows through one lake, Aiken Lake, located in the upper-most Mesilinka reach. Three lakes are found in the Mesilinka tributaries, namely, Tutizzi Lake, located on Tutizzi Creek; and Carina and Tomias Lakes, located on Carina Creek. All three lakes are considered to contain excellent fish assemblages and/or fish habitat. During the 1970's and early 1980's a fly-in fishing lodge operated on Tutizzi Lake.

Currently T&T Fishing (T. Gratton), located at approximately km 12 from the mouth, provides guiding services on the Mesilinka mainstem and area rivers. Otherwise there is little in the way of recreational or other services on the Mesilinka system. The river is open to angling from July 1 - March 31 with no harvest of bull trout from September 1 - October 15 due to fall spawning. Starting in April 1996 there will be no harvest of bull trout from any stream in the Omineca region. Arctic grayling daily catch limits were reduced from 10 per day in the early to mid 1980's to 5 per day and finally to 3 per day in the early 1990's. Since the fall of 1994 there has been a total closure of fishing for Arctic grayling (i.e. total closure in the form of catch and release regulation). The grayling and bull trout regulations are for conservation purposes (D. Cadden, Ministry of Environment, Lands and Parks, MELP, Omineca Region, Prince George, pers. comm.).

Angling activity (apart from pressure on Arctic grayling) is light with the exception of high pressure in the Mesilinka embayment area (Omineca Arm), which is typical for most Williston Reservoir river fisheries (Blackman et al. 1990). It has not been uncommon to see 12-15 fishermen in the area of the embayment (B. Blackman, MELP, Prince George, pers. comm.). Angling effort on the remainder of the river is light except where logging roads provide access. There are, however, a few ideal locations (deep pools with excellent cover and substrate, near access points) and these may face high pressure (B. Blackman, MELP, Prince George, pers, comm.) from tourists and local residents, including residents of three logging camps in the area.

Access to the river is facilitated by mainline and spur logging roads which parallel the river, with bridge crossings at two locations (Fig. 2). Additional biophysical characteristics of the study area related to weather, soils and geology are outlined in Blackman et al. (1990).

Nation River

The Nation River is located approximately 100 km south of the Mesilinka River, and also flows into the Williston Reservoir (Fig. 1). The river is headed by a chain of 5 large lakes (the Nation lakes) that are situated at the southern end of the Omineca Mountains. The Nation River has a drainage area of 5880 km^2. This compares to a drainage area of 1530 km^2 for the

Manson River, located to the south, while the Mesilinka River drainage area (3285 km^2) is intermediate between the two (Bruce and Starr 1985). Mean summer water temperatures and June flow rates in the Nation River are higher than in the Mesilinka River (20-30% higher, respectively). The Nation River tends to be more nitrogen (N) limited than the Mesilinka River, while both rivers are equally phosphorous (P) limited.

The Nation River, while an extremely attractive candidate (as described in Slaney 1993), was not selected as the river for fertilization studies because the higher flows and higher N-limitation would require larger and more costly amounts of fertilizer than required for the Mesilinka River. Also, the Mesilinka River was more typical of the cool streams within the Williston Basin. If the Mesilinka program produces positive results from the current set of planned fertilization experiments, the Nation River could be a future recipient in the Peace/Williston Fish and Wildlife Compensation Program.

Peace/Williston Fish and Wildlife Compensation Program

Establishment of the Williston Reservoir in 1968-1972 flooded substantial portions of area rivers, resulting in the loss of riverine habitats utilized by salmonids, Arctic grayling and mountain whitefish. The present Mesilinka project is one mitigation option to compensate for loss of fish habitat. The significance of the riverine habitat losses can be gauged from user surveys which were conducted in towns located within the Williston watershed (Anon. 1991). Although current use is biased to lakes and the reservoir, angler preference is slightly biased to rivers (48%) over small lakes (45%), and these are in contrast to the reservoir (8%) which is of limited interest to anglers. Similarly, preference by the stakeholders is for compensatory fish enhancement to be directed at streams and small lakes with target species prioritized as rainbow trout, Arctic grayling and bull trout. Reservoir embayments were rated as tertiary targets. These habitat preferences are consistent with angler demand surveys conducted elsewhere in western North America. For example, in Idaho, where angler use is equally distributed between lakes and streams, 34% preferred angling trout in lakes and 66% preferred angling for trout in streams (Mallet 1980).

Consistent with angler demand, the present management plan for the Peace/Williston Fish and Wildlife Compensation Program places primary emphasis on enhancement of streams and small lakes by means of pilot projects coupled with evaluations (Anon. 1990). The fish component of the Peace/Williston Fish and Wildlife Compensation Program operates on the basis of a six million dollar notional fund, of which only the annual interest is utilized to deliver program goals, programs which include the current Mesilinka fertilization project. In this way, funding and program continuance may be possible in perpetuity.

Selection of the Mesilinka River for Riverine Fertilization

The potential for riverine fertilization to substantially enhance salmonid and grayling production is limited to those streams with a) adequate juvenile recruitment; b) nutrient deficiencies; c) warmer streams with mean summer temperatures more than 10 °C, preferably 12-15 °C; d) abundant adult rearing habitat; e) numerous angling sites and access points; and *f)* high over-winter survival, the latter positively related to winter flow level and availability of pool habitat.

Prior to selection of the Mesilinka River for stream fertilization, other rivers in the Williston watershed were also evaluated. The most probable candidates for success are warmer systems with suitable pool to riffle ratios. These are primarily situated on the accessible west slope of the Parsnip Arm and include the Nation, Manson, Osilinka and Mesilinka rivers (Fig. 1). Smaller streams include Blackwater Creek (Parsnip Arm) and Clearwater Creek (Peace Arm).

During 1991 to 1992, potential pilot streams were monitored for water temperature and water chemistry. The Nation and Manson rivers are lake-headed and warmest based on earlier measurements, but both rivers are deficient in nitrogen (more deficient than the Mesilinka River) as well as phosphorus. The Nation appears to have an ideal temperature regime, and in the long-term, it could be a main fertilization target (mean July-September flow about 50 $m^3 \cdot sec^{-1}$ and summer water temperature is 14-16 °C). The Manson River is also a suitable candidate in terms of temperature and flow, except mainstem fish populations are currently very sparse and there are recent sedimentation impacts associated with forest harvesting on a main tributary (B. Blackman, MELP, pers. comm.).

The Osilinka and Mesilinka rivers are primarily phosphorus deficient (and thus the cost of fertilizer input less than that of the Nation and Manson rivers), but the Osilinka River is unstable in the lower reach and slough-like in the middle reach, thereby restricting its potential to the upper reach. In contrast, the Mesilinka River is near-ideal in physical habitat within its upper, middle and lower reaches. Side-channel and tributary fish rearing areas are likely sufficient, particularly if improved in productivity and habitat. Access by logging roads and boat (canoes, inflatable boats and jet boats) is available. Mean monthly water temperatures in the Mesilinka middle and lower reaches during July, August and September are within the lower acceptable range to augment salmonid growth, but specifically, are more favourable for Arctic grayling, bull trout and mountain whitefish compared to rainbow trout. Based on these variables, the Mesilinka River was chosen for further study and pilot testing. Planned tasks (1992 and 1993) were generally accomplished as scheduled and details of methods and results are provided in the following subsections.

METHODS

The 1992 and 1993 sampling programs on the Mesilinka River (mainstem and selected tributaries) consisted of sampling stream flows, water temperature, water chemistry, periphyton chlorophyll *a*, benthic insects, and fish species. The Nation River (functioning as an external control) was also sampled but to a lesser extent.

To facilitate the method of "before and after" controlled comparisons (as described in Stewart-Oaten et al. 1986) to measure responses to fertilization, three reaches were designated in the Mesilinka River, namely Blackpine (the experiment control reach), and T1 and T2 (designated fertilizer treatment reaches) (Fig. 2). These reaches are 7.5, 7.2 and 8.1 km in length, respectively, with wetted widths of approximately 35 - 40 m (in August), and were chosen on the basis of accessibility and general similarities.

Biophysical Methods

Flow Measurements

Addition of nutrients to maintain a target instream concentration is a function of discharge, and therefore stream flow measurements are required to calculate and adjust the nutrient input rates. Mesilinka River 1992 and 1993 flows were obtained from Water Survey of Canada (WSC) who maintain a measuring station on the Mesilinka River above Gopherhole Creek (Figs 2 and 3). Nation River flows were also obtained from two WSC stations (upper and lower stations).

Water level gauges were installed in four tributary creeks (Gopherhole, Control, Culvert and Carina Creeks) in 1992, and additionally installed in Fatfish Creek in 1993. Water velocities (using a Marsh McBurney current meter), and water levels were measured in the five tributaries during the summer months (mid-June to August) to establish stage-discharge relationships. Measurements were taken every 0.5 m across the stream width, and velocities were measured at 60% total depth from the surface. Flows were calculated for each individual cell and then summed to obtain total discharge. Subsequent water level readings were converted to flow estimates using the established relationships.

Water Temperatures

Water temperatures (1992) were recorded with Ryan thermographs in the Mesilinka mainstem, in reaches Blackpine, T1, and T2 (July to mid-September). Min-max thermometers (Brannan) recorded temperatures in four tributary creeks (Gopherhole, Control, Culvert and Carina Creeks). To obtain a daily mean water temperature with the min/max thermometers, the daily minimum and maximum temperatures were averaged.

In 1993, Ryan thermographs were installed in the Mesilinka River at Blackpine and Gratton's Camp, in Gopherhole, Control, Culvert and Carina creeks, and in the Nation River (upper WSC station), from mid-June to mid-September. A min/max thermometer was installed in Fatfish Creek.

Water Chemistry and Transparency

Dissolved nutrient concentrations were sampled and measured as described in Johnston et al. (1990). Nutrient water chemistry variables measured in this project were: low-level nitrate nitrogen (nitrate-N), ammonium-nitrogen (ammonium-N), total nitrogen (total-N), low-level ortho-phosphorus (also called soluble reactive phosphorus, SRP) and total dissolved phosphorus (TDP). All of the above nutrients are measured in dissolved rather than particulate form. Nutrients, and in addition, total alkalinity, pH and total dissolved solids (1992 only) were sampled on a monthly basis. Water samples were placed immediately on ice in a cooler, then transported within two days to Zenon Environmental Laboratories in Burnaby. Nonfilterable residue (NFR) and turbidity samples (indicators of water transparency) were collected weekly and frozen until they were shipped with the monthly water samples. Handling and analysis of samples followed standard methods as in APHA (1985). Transparency was also measured *in situ in the mainstem using Secchi disk visibility.*

Water sampling sites on the Mesilinka mainstem were at Blackpine, Road-end (located immediately upstream of T1), T1 *and* T2 *(Fig. 2). Tributary stations were at Culvert and Gopherhole creeks (in 1993 at 2 sites each in these creeks, above the nutrient input and at the lower road and bridge, respectively), Control and Carina creeks. Fatfish Creek and the Nation River were sampled in 1993 only.*

Periphyton Accrual

Periphyton accrual, as *measured by peak chlorophyll a content, provides a useful indicator of the potential effects of nutrient stimulation (Perrin et al.* 1987). *Periphyton levels increase due to fertilization and then after approximately two years they typically subside to modestly elevated levels (Peterson et al.* 1993) *or nominal levels (Slaney and Ward* 1993) as *grazing insects respond to the increased algal production.*

Periphyton accrual was measured as described in Bothwell (1988) and Johnston et al. (1990). In this method, plexiglass plates, black in colour, were bolted to concrete blocks using 4 stainless bolts per block. Styrofoam (30 cm x 30 cm x 0.6 cm) was fastened to the plexiglass plates with stainless steel wire. At each site the blocks were placed in a pool "tailout" at a depth of about 0.5 m. Two 2 cm cores of periphyton (duplicate samples) were sampled at approximately 2 to 4 week intervals from the styrofoam substrata at each station, and each was analyzed as in Bothwell (1988).

In 1992, 10 periphyton sampling blocks were installed from mid-July to mid-September at each of seven stations, namely, at Blackpine, T1 and T2, and in Carina, Control, Culvert and Gopherhole creeks. In 1993 (July - September) sampling stations were located at two sites in each of the Blackpine, Road-end, T1 and T2 reaches. Sampling stations were also located at two sites at Gopherhole and Culvert creeks (site #1, downstream, d/s, of the nutrient input; site #2, upstream, u/s, of the nutrient input), and at one site each at Control, Fatfish, and Carina creeks. Optimal water depths for measuring periphyton accrual are 20 cm in small streams, to 40 cm in larger streams, and velocities are 0.2 to 0.4 m sec^{-1}. Consequently, the test sites were moved short distances as required, to compensate for receding flows.

All periphyton samples were stored and frozen until they were sent to Zenon Laboratories, Burnaby for analysis. Styrofoam substrata were replaced after periphyton accrual peaked, or after 4-6 weeks (as in Johnston 1990). Thus, each set of chlorophyll *a* determinations provided replicated accrual rates and peak levels in each of the three reaches.

Benthic Insects

Assessment of the colonization of artificial substrate by aquatic insects provides a useful indicator of the response of salmonid food chains to enrichment, and is thus a good indicator of the potential for trout growth (Slaney and Ward 1993). Using this method, cylindrical plastic baskets (22 cm in diameter by 13 cm in depth; 0.04 m^2 in area and 0.05 m^3 in volume) containing 3 - 6 cm diameter gravel were installed in riffle areas within the control and test reaches. For statistical purposes at least five baskets were installed at each reach. Baskets were surrounded by cobbles to minimize dislodgement, then left to colonize with insects for 6-8 weeks. Based on earlier studies in other rivers, 80 % of the peak abundance of insects is usually attained in six weeks and peak abundance attained at eight weeks (Mason et al. 1973). Composition of taxa collected from the insect baskets is usually found to be similar to natural substrate.

In 1992, twenty of the benthic insect sampling baskets were installed by mid-July in each mainstem reach (Blackpine, T1, T2). In 1993, ten insect basket samplers were placed in each of the same three reaches, and six baskets were installed in the Nation River at the upper

WSC station. In all cases they were retrieved by mid-September after 7-8 weeks of colonization. At removal a Surber sampler (0.2 mm mesh net) was placed directly downstream of the basket, the gravel scrubbed and the contents of the basket (insects and detritus) were washed into the sampler. The contents were placed into labelled bottles and preserved in 10% formalin solution. Insect sorting (1992 and 1993) was completed by staff at the Abbotsford Fish Hatchery, and identification (1992) was completed at Zenon Laboratories, Burnaby. Retrieval problems in 199 resulted in collection and identification of only the larger sized benthic insects.

Biomass measurements were taken of the 1993 samples. In this method, samples previously having been cleaned and stored in alcohol, were dried ("blot-dried") between paper towels and then allowed to air dry for 2 - 3 minutes before weighing (Johnston et al. 1990), with the subsequent weights reported as grains per 0.04 m^2 area. Taxonomic identification of the 1993 samples is incomplete.

Fish Growth, Abundance and Size Distribution

Adults: During July and the first two weeks of August 1992, fish were sampled in the Mesilinka River, reaches Blackpine, T1 and T2, using standard angling techniques with barbless hooks. Fish lengths (fork-length) and weights were measured and recorded for catchable (mainly $\geq$ 20 cm) rainbow trout, Arctic grayling, bull trout and mountain whitefish. Scales of rainbow trout and grayling were sampled for size-at-age determination to provide pre-fertilization data. Scales were processed and aged as described in Ward and Slaney (1988). Fish caught during the July angling were tagged with green Floy anchor tags for annual growth rate studies. Single factor analysis of variance (ANOVA) was used to determine whether there were significant differences in fish size per age (fish condition) between the three reaches (1992), using the most abundant age and species as examples, namely, age 3+ rainbow trout and age 4+ Arctic grayling.

Low conductivity, as well as the sporadic distribution and relatively low abundance of grayling and rainbow trout, confirmed that boat-shocking would be ineffective in the Mesilinka River, and therefore an alternative method for estimating fish populations was utilized, namely underwater census (also referred to as snorkel surveys, or swim counts).

Fish caught in the first two weeks of August were tagged with red Floy tags for subsequent population estimate studies using mark-recapture techniques. In August 18 - 23, 1992, highly standardized underwater counts were completed by a crew of six experienced divers using the method of Slaney and Martin (1987). Water temperatures at the time of each swim were 11 °C or higher since otherwise fish are found to be inactive and easily missed (Slaney and Martin 1987). Underwater census has been previously conducted by Fisheries Program staff in several trout streams in British Columbia including the Nechako River (Slaney 1986), St Mary River (Slaney and Martin 1987), Sumallo River (Slaney and Godin 1989), Adam

River (Slaney et al. 1993) and Big Silver Creek (Toth et al. 1993). Systematic evaluations of underwater census techniques are found in Northcote and Wilkie (1963), Goldstein (1978), Griffith (1981), Gardiner (1984), Hankin and Reeves (1988), and Heggenes (1990), which confirm the usefulness of the method. Marking fish up to two weeks in advance of recapture (in the current study, recapture by observation) is recommended by Vincent (1971).

For the 1992 underwater census, fish in the three Mesilinka reaches were counted over a five to six day period. Within each of the three reaches, each float was replicated twice at random, within shore and mid-channel lanes. Tagged (red tags, i.e. "recaptured" fish) and untagged fish were recorded by species and by length category within each of the three reaches. Underwater census combined with mark-recapture techniques were then used to calculate correction factors for the underwater swim counts (as in Slaney and Martin 1987), since not all fish are detected in every swim. These correction factors can be used in subsequent years when mark/recapture estimates are not conducted.

Underwater counts were again carried out in 1993 (August 17 - 22). Instead of red tagged fish as in 1992, fish (147 in total) were tagged in the previous 2 weeks with one of three different colours, namely, pink, yellow and white, in Blackpine, T1 and T2, respectively. Additional fish (various species) were caught during the first two weeks of August 1993. They were not tagged, but length and weight measurements and scale samples were taken. Also in 1993, tagged fish from 1992 (12 fish) were recovered, lengths, weights, location and tag numbers recorded, and scale samples retrieved.

Fish data at the Nation River was collected by angling in both July 1992 and 1993. Rainbow trout and lesser numbers of Arctic grayling were caught, weight and length measurements were recorded and scale samples retrieved. Angling took place within two mainstem reaches (both below Chuchi Lake), namely, Sylvester Creek to Rainbow Creek which is downstream of the Ft. St. James bridge; and upstream of the Ft. St. James road bridge to within 4 km of Chuchi Lake.

Juvenile Fish: To record sizes and ages of juvenile fish moving downstream into the Mesilinka mainstem, downstream cable-supported net-traps were operated on three tributaries (Gopherhole, Control and Culvert creeks) from late July to early September, 1992. Several adult fish were also caught. Fish length and weight measurements were recorded and scale samples retrieved for subsequent size-at-age studies. Trapping on a fourth tributary (Carina Creek) was attempted but proved too logistically difficult to operate.

To obtain additional size-at-age data on each rearing species, juvenile fish were sampled with electrofishing gear. This activity was conducted twice in the tributaries, in August and September, 1992. On the second sampling in September, Petersen-type mark-recapture estimates were completed in 100 m sections.

In 1993 fish traps were again placed in Gopherhole, Control and Culvert creeks. Repetitive storm events throughout the summer impacted the traps constantly and reducing their effectiveness, therefore, by mid-August, trapping was discontinued and electrofishing initiated. Electrofishing of Fatfish, Control, Culvert, and Gopherhole creeks was undertaken to determine fish species abundance and sizes. In each creek approximately 200 - 400 m sections were fished. In late August to early September, Petersen-type mark-recapture estimates were carried out in Gopherhole, Carina, Control, and Culvert creeks, within 100 m enclosed sections of representative salmonid rearing habitat.

Electrofishing of Mesilinka River side channels and river margin habitat was initiated in late August to mid-September 1993. Emphasis was placed on locating rearing habitat of juvenile grayling and rainbow trout. Several sites in each reach were sampled. Length and weight measurements were recorded and scale samples retrieved.

Tributary Fertilization

Pilot fertilization of two tributary streams, Culvert and Gopherhole creeks, was conducted July 8 to September 8, 1993. The liquid fertilizer drip stations (each comprised of a large-sized polyethylene storage tank, fitted with hose and valve, and with a gravity-based dispensing mechanism) were placed as far upstream in the two tributaries as possible (4-6 km). Input of ammonium polyphosphate (10-34-0) was set to deliver an instream target of 5 µg P/L. A small graduated test tube was used to measure the volume of drips over 2.5 minutes. However, the drip rates once set would decrease very significantly over a period of 24 hours, because of viscosity changes in response to temperature, and suspected problems with precipitates and in-line debris. In attempts to achieve a near constant drip rate the fertilizer was diluted with distilled water 2:1, thus increasing the drip rate. This dilution was not effective, therefore the drip rates were increased two-fold, to compensate for the decline in drip rate over time (assuming that the lowering drip rate over time would provide a mean input rate to attain the target P). Drip rates were checked and readjusted one to two times a day, every two to three days.

RESULTS AND DISCUSSION

Weather

The closest Environment Canada weather station to the study area is located at Germansen Landing, a road crossing on the Omineca River, about 55 km due south of the Mesilinka River, Reach T2. Mean air temperatures in May, June, July, August and September of 1992 were 6.7,13.7,15,13.2, and 6.4 °C, respectively; and in 1993, 11.1, 11.8, 13.4, 13.7 and 9.7 °C, respectively. May and September 1993 were much warmer than in 1992 (40 and 34% warmer, respectively), otherwise mean monthly temperatures between the two years were quite similar, and near the 1961-1990 average (Fig. 4, and Appendix A).

Summer precipitation (Germansen Landing) by month varied greatly between the two years (Fig. 5). Total precipitation for the months of May through August was 73 mm (1992), and 307 mm (1993) compared to an average of 201 mm (1961-1990). Clearly, 1993 was a very wet summer (four-fold more precipitation than in 1992) and 1992 a drought summer (compared to the 1961-90 average). If, however, September is included in the total precipitation figure, then 1992 and 1993 were more similar (278 and 319 mm respectively) and both were more than the 1961-1990 average (248 mm). There will likely be some differences between weather conditions at Germansen Landing and in the Mesilinka watershed, but these are likely minor and would not affect the relative differences in weather between years.

Hydrology

Mesilinka and Nation Rivers

The ice-free period on the Mesilinka River is normally from mid-April to the end of October or beginning of November, however, ice-cover into May can occur (e.g., in 1985). The Nation River has similar ice-free periods. In 1992 and 1993, both rivers were completely ice-free from May through October.

Mean monthly flows in the Mesilinka River (at WSC station above Gopherhole Creek) in June, July, August and September 1992 were 231, 84, 30 and 32 m^3 sec^{-1}, respectively; and in the same months of 1993 were 115, 74, 53 and 30 m^3 sec^{-1}, respectively (Fig. 6, and Appendix A). Maximum daily flow in June 1992 was 349 m^3 sec^{-1}, in June 1993 was 115 m^3 sec^{-1}, a

three-fold difference between the two years which likely reflects differences in snow pack levels between the two years. August flows in 1993 were much higher than in 1992 (56% higher), reflecting increased August 1993 precipitation.

Maximum monthly flows in the Nation River occur in May and June; in the Mesilinka River, in June and July (Fig. 7). Total discharge volume in the Nation River (near the mouth) during the months April through October (1992 and 1993) was almost double the volume in the Mesilinka River. Nation River mean monthly flows in April - June (1992 and 1993) were 1.5 to 6 times higher than flows in the Mesilinka River. Conversely, July - October mean monthly flows in the two rivers were very similar, and in August and September 1992 they were slightly higher in the Mesilinka. Thus, the Nation is a much larger river than the Mesilinka in spring to early summer, but about the same in volume from mid-summer through fall. These striking variations between the two rivers probably reflect the lake-headed character of the Nation River over the Mesilinka River.

Mesilinka Tributaries

In 1992 only three flow measurements (one each in July, August and September) were made in each of three tributaries, Carina, Control, and Culvert creeks, and four measurements in Gopherhole Creek (Fig. 8). Flows were again recorded in 1993 but more extensively than in 1992. Based on these records, Carina Creek carries the most water (up to 5.8 m^3 sec^{-1}) followed by Culvert Creek, and by Gopherhole and Control creeks which carry about the same flow (Fig. 8). Flows in Fatfish Creek (Fig. 8), measured for the first time in 1993, were the lowest of the five measured tributaries (as low as 0.24 m^3 sec^{-1}). In 1993, recorded flows peaked at the beginning of July; three additional but minor peaks, probably rain driven, were observable in most of the tributaries in August. Of note, flows were only measured beginning in mid-June, and thus actual peak flow may have occurred in May or early June as occurred in the Mesilinka mainstem.

Ten wetted width measurements were taken in 1992 in each stream. The average wetted width of Carina Creek was 6.5 m (on September 10th), Culvert Creek 5.0 m (September 4th), Control Creek 3.6 m (September 4th), and Gopherhole Creek 3.4 m (September 4th).

Water Temperatures

Mesilinka and Nation Rivers

In 1992 mean daily water temperatures in the Mesilinka River (upper, Control reach at Blackpine) were 10 °C at the beginning of July, peaking at 15.4 °C at the beginning of August (lower reach, T2), and declining to 6 °C degrees (upper and lower reaches) by the middle of

September (Langston 1993a). Variation between minimum and maximum daily temperatures was approximately 1 - 2 °C. Mean monthly temperatures ranged from 11.6 - 12.6 °C (July), to 12.1 - 12.8 °C (August) (Fig. 9). Temperatures increased by only up to about 1 °C in a downstream direction, from Blackpine to Gratton's Camp.

Nation River 1992 mean monthly water temperatures were 16.9 °C in July and 16.8 °C in August (Langston 1993a). The Nation River peaked at 21.8 °C (instantaneous measurement), with a daily mean of 20.7 °C, August 2nd, which is well within the upper limit for salmonid survival, but sub-optimal in a food-limited (oligotrophic) water body (Brett et al. 1969).

Mean monthly water temperatures in 1993 (July and August) in both the Mesilinka and Nation rivers were a little lower than in 1992 (Fig. 9), which were probably due to higher 1993 precipitation levels and cooler ambient temperatures. Mesilinka River temperatures in the upper to lower reaches, respectively, ranged from 11.2 - 11.5 °C (July), to 11.9 - 12.1 °C (August) (Langston 1993b). Peak daily mean temperature was 14.6 °C, at the beginning of August. These temperatures are within the lower acceptable range to augment salmonid growth, but are more favourable for Arctic grayling. Nation River 1993 mean temperatures were 14.4 °C in July and 15.4 °C in August (Langston 1993b). Clearly the Nation River is warmer than the Mesilinka, by up to 5 °C mean monthly temperature in July 1992. [Refer to Langston (1992, 1993a and 1993b) for additional temperature data].

Mesilinka Tributaries

Water temperatures in 1992 were highest in Carina Creek (maximum recorded temperature 20 °C), followed by Gopherhole, Control and Culvert creeks with maximum temperatures of 16, 14 and 14 °C, respectively (Fig. 10). Mean monthly water temperatures for four of the tributaries in 1993 were recorded by Ryan thermographs. In comparison to the Mesilinka River mainstem, Carina Creek was warmer (based on mean monthly temperature) and the other three tributaries cooler (Fig. 11). Carina Creek had a mean August temperature of 14.4 °C; the other tributaries, namely Gopherhole, Culvert and Control creeks, had mean temperatures of 9.1, 9.0 and 8.2 °C, respectively (Langston 1993b). Daily variations between minimum and maximum temperatures (1993) were usually between 1 and 2 °C and occasionally up to 3 °C. Fatfish Creek maximum daily temperatures in 1993 ranged from a high of approximately 15 °C in July (beginning of measurement period) to a low of about 3 °C in mid-September (Fig. 11).

Mesilinka and Nation Rivers

Nutrients: At most locations three samples were taken in 1992 (July, August and September) and three in 1993 (June, July, August). The Nation River was only sampled in 1993, and only two times. Any conclusions in this subsection should be drawn with caution due to the limited data.

At the Mesilinka mainstem sites (and tributaries) soluble reactive phosphate (SRP) was at or below the detection level of 1 $\mu g\ L^{-1}$ in all the 1992 measurements (Fig. 12) and most 1993 samples (Fig. 13). Total dissolved phosphorous (TDP) was at or below the detection limit of 3 $\mu g\ L^{-1}$ on most occasions in both 1992 and 1993. Nitrate-nitrogen (nitrate-N, which usually includes small amounts of nitrite as well) ranged from 13 to 26 $\mu g\ L^{-1}$ at the three sites (Blackpine, T1 and T2) (1992), and from 5 to 22 $\mu g\ L^{-1}$ in 1993 (Blackpine, Roadend, T1 and T2 sites) (detection limit 5 $\mu g\ L^{-1}$). Only 3 of 9, and 2 of 11 samples in 1992 and 1993, respectively, were at or above 20 $\mu g\ L^{-1}$ nitrate-N. Streams with levels of nitrate-nitrogen below 20 $\mu g\ L^{-1}$ are usually considered N-limited (Slaney et al. 1986, Slaney and Ward 1993). Also, based on the limited data set, nitrate-nitrogen levels decreased over both the 1992 and 1993 season at most sites (Fig. 12, 13).

Total organic nitrogen (TON) at the Mesilinka River sites ranged from 40 to 280 $\mu g\ L^{-1}$ in 1992 and from <40 to 160 $\mu g\ L^{-1}$ in 1993 (detection limit 40 $\mu g\ L^{-1}$). Ammonium-nitrogen (ammonium-N) ranged from <5 to 18 $\mu g\ L^{-1}$ in 1992, and from <5 to 8 $\mu g\ L^{-1}$ in 1993 (detection limit 5 $\mu g\ L^{-1}$). Adding the measured ammonium levels to the nitrate-N levels would suggest that N-limitation was not a problem in the Mesilinka River, at least not in 1992. Whether and when organic nitrogen is converted to nitrate or ammonia is unknown.

Based on the two nitrate-nitrogen records from the Nation River recorded in 1993, (<5 and 7 $\mu g\ L^{-1}$), the Nation River is more N-limited than the Mesilinka; firmer conclusions await additional data (although lower levels would be expected in a large lake-headed system). The two Nation River SRP samples were also below the detection limit of 1 $\mu g\ L^{-1}$ confirming (tentatively) very oligotrophic conditions.

Other variables: Total dissolved solids (TDS), pH and total alkalinity were measured in 1992 but not in 1993. Mesilinka River (1992) values of TDS were 48-90 $mg\ L^{-1}$, pH 7.5 - 7.8, and total alkalinity 29 - 60 $mg\ L^{-1}$ (Fig. 12).

Total alkalinity can be used as an indicator of fish abundance or size (Ptolemy et al. 1991). According to Ptolemy et al. (1991) model, Mesilinka River total alkalinity values (29 -

60 mg L^{-1}) and TDS values (48 - 90 mg L^{-1}), fall within a range suggesting a moderate level of fisheries productivity. These figures compare favourably to those of the Nechako (Slaney et al. 1994), Silverhope and Skagit rivers which have total alkalinity values of 28 - 44 mg L^{-1} and TDS averaging 70 mg L^{-1}, and these are associated with very low nutrient concentrations (Rosenau and Slaney 1983).

Nonfilterable residue (NFR) (detection limit 4 mg L^{-1}) at Gratton's Camp (1992) ranged over the summer from 6 - 30 mg L^{-1}, and turbidity from 1.5 - 5 NTU (detection limit 0.1 NTU) (Fig. 12). Summertime NFR values in 1993 at various sites ranged from <4 to 17 mg L^{-1}, and turbidity ranged from 0.1 - 2.8 NTU. Secchi disk depths (visibility from the water surface) ranged from 0.7 to 2 m (1992) and from 1.2 to 2 m (1993) (Appendix A, Tables A6-A7). These values suggest sufficient water clarity exists for periphyton growth in areas with available nutrients.

Mesilinka Tributaries

In each of 4 tributaries in 1992 (3 - 4 records per tributary), TDP and SRP were both at or below their respective detection limits of 3 and 1 µg L^{-1} (Fig. 14). Nitrate-N levels varied from below the detection limit of 5 µg L^{-1} (Carina Creek), to averages of 8, 32, and 20 µg L^{-1}, respectively, in Gopherhole, Control and Culvert creeks. Ammonium-N levels ranged from <5 to 36 µg L^{-1} with Carina Creek appearing to have the higher concentrations. TON ranged from <40 to 130 µg L^{-1}, with the higher concentrations present in July, and lower in September.

In 5 tributaries in 1993 (2-3 records per tributary) TDP ranged from <3 to 4 µg L^{-1}, and SRP from <1 to 5 µg L^{-1} (Fig. 15). Nitrate-N ranged from <5 µg L^{-1} to 30 µg L^{-1}; ammonium-N from <5 (most values) to 7 µg L^{-1}; and TON from 40 to 250 µg L^{-1}. Phosphorous levels in the two fertilized reaches (in Gopherhole and Culvert creeks) were erratic, and mostly very low (similar to the nitrate levels), suggesting a) the dispenser mechanism may have been faulty for use at such low dispensing quantities; or b) occurrence of rapid uptake of N (and P) by periphyton and other autotrophic organisms at the downstream sites. The former is more likely, and indicates that a shift to a more reliable method such as slow-release pellets or peristaltic pump is needed in the future.

Based on the data accumulated in 1992 and 1993 it would appear that Control Creek contains higher nutrient levels than the other tributaries. The creeks in general do not appear to be significant sources of nutrients to the Mesilinka mainstem and in fact, apart from Control Creek may be as nutrient limited as the Mesilinka mainstem; firmer conclusions require additional data collection.

Periphyton Accrual

Mesilinka and Nation Rivers

Periphyton accrual, based on measurement of chlorophyll *a* content (mid-July to mid-September 1992), peaked at approximately the same rate and low magnitude (12 - 16 mg m^{-2} over 8 weeks) at Blackpine, T1 and T2 (Fig. 16). This suggests that the three sites are similar for comparison of impacts from input of nutrients in future years.

Over a 6 week period in the summer of 1993, peak accrual ranged from approximately 7 to 13 mg m^{-2} chlorophyll *a* (Fig. 16) and thus a little lower, and with a little more variation than in 1992. Peak accrual in the Nation River 1993 (one site only) was approximately 13 mg m^{-2} (Fig. 16) and thus the river appears similar to the Mesilinka River.

Mesilinka Tributaries

Periphyton accrual in three of the four Mesilinka tributaries in 1992 (Fig. 17) were much higher than accrual measured in the mainstem. In Carina Creek, chlorophyll *a* increased to a peak of approximately 115 mg m^{-2} in about one month. Gopherhole, Control and Upper Culvert creeks had peak accruals of 36, 23 and 9 mg m^{-2}, respectively. Peak accrual in the tributaries in 1993 (7 - 10 week duration) ranged from 17 - 87 mg m^{-2}, with the highest values in Fatfish Creek, and the lowest in Gopherhole Creek at the site upstream of the fertilizer input (Fig. 17). Variation in accrual occur due to variables which include availability of nutrients, water temperature, light and water velocity.

Peak chlorophyll *a* values in Gopherhole Creek (1993) were 17 mg m^{-2}, at the site upstream from fertilizer (phosphorous) input, and 38 mg m^{-2}, at the downstream site, i.e., a 2-fold increase between upstream and downstream locations, but similar to the 1992 value (36 mg m^{-2}). Visual observations indicated only minor algae growth on the stream substrate. Chlorophyll *a* levels below 40 mg m^{-2} were also observed in other studies to be nominal (Slaney et al. 1994b). Peak chlorophyll *a* readings in Culvert Creek were 57 mg m^{-2}, at the site upstream from the fertilizer input, and only 33 mg m^{-2}, at the downstream site, whereas the reverse of these results were expected. Unusually high water flows in 1993 may have caused the streams to become more nitrogen co-limited and therefore the responses to P input in the two creeks were nominal. However, a marked periphyton response was observed in the Mesilinka River for several hundred metres downstream from the Culvert Creek confluence, suggesting that nitrogen may have been less limiting in the mainstem.

Drip rates were a problem in dispensing the required volume of fertilizer. A shift to slow release fertilizers, being tested during 1993 - 94 for dissolution rates at the Ministry of

Environment Lands and Parks (MELP), Abbotsford Fish Hatchery, Research and Development Section, would be more efficient because drip systems require frequent adjustment at the low rates of delivery (0.2 L min^{-1}).

Benthic Insects

Technical problems occurred with gathering benthic samples in 1992. Nevertheless a listing of the benthos found at each site are available on file. Included, and most common are various genera from the orders Plecoptera (Chloroperlidae family), Empheroptera (Baetidae family) and Diptera (Tipulidae and Chironomidae families).

Wet weights ("blot dried" weights) were recorded in 1993. These provide an estimate of total biomass for comparisons between sites (Fig. 18) and eventually between years. Biomass at Blackpine, Tl and the Nation River (6.0, 5.3 and 8.0 g m^2, respectively) are similar, while T2 (0.55 g m^2) is an order of magnitude less. By comparison, samples from the Salmon River on Vancouver Island weighed between 5 and 12 g m^2 at unenriched sites, and up to 38 g m^2 at enriched sites (Slaney et al. 1994). The reasons for low values at T2 are unknown. Considering periphyton accrual was similar at all sites in 1992-93, benthic invertebrate productivity ought also to be similar. Possible reasons include a) enhanced predation by fishes in T2; b) unknown habitat limitations; or c) error in sampling techniques, for example, exposure of T2 baskets to fluctuating water levels and desiccation.

The 1993 samples await identification and quantification by genera, and will be reported in future reports. Based on cursory observations, members of the Chironomidae family are probably the most numerous component.

Fish Sizes, Growth and Abundance

Most of the data reported in the following subsection pertains to rainbow trout, bull trout, Arctic grayling and mountain whitefish. Other species occasionally caught or observed include burbot, sucker, sculpin, chub, squawfish and other minnow species. In total, in each of the two years approximately 700 fish were caught by methods which included angling, electrofishing, trapping and gill netting. Capture rates of ail fish declined rapidly with declining water temperature through September.

Fish Presence, and Size and Age Composition

A tally of fish caught is provided in Table 1; rainbow trout were most numerous, however, this is based largely on the type of sampling methods used (mainly angling and electrofishing), not necessarily on actual numbers in the rivers, for example, mountain whitefish were the most abundant fish species based on underwater counts.

Length (fork length) and weight records (median and maximum) for Mesilinka and Nation River salmonids are summarized in Table 2. Maximum size of bull trout was 810 mm and 4.6 kg. Mountain whitefish were the smallest salmonid species with median and maximum lengths of 270 and 339 mm, respectively.

Length (fork length) frequency distributions for rainbow trout and Arctic grayling (1992-93) are detailed in Fig. 19. Rainbow trout and Arctic grayling of the Mesilinka River exhibit a slightly wider distribution range than for the same fish in the Nation River. Most rainbow trout were found in the 200 - 300 mm and 200 - 350 mm range, respectively, in the Nation and Mesilinka rivers; most Arctic grayling were found in the 250 - 350 mm, and 250 - 390 mm range, respectively.

Apart from a small number of older rainbow trout and Arctic grayling found in the Mesilinka River, the age composition of rainbow trout and Arctic grayling were similar between the two rivers (Fig. 20). In both rivers age 3+ rainbow trout and age 4+ Arctic grayling predominated.

In 1992, average length-at-age of age 2+ to 4+ Mesilinka River rainbow trout (167, 216 and 265 mm respectively) were lower (by 3 to 5%) than 2+ to 4+ rainbow trout in the Nation River (176, 223 and 277 mm, respectively) (Fig. 21). Average weight-at-age of age 2+ to 4+ Mesilinka River rainbow trout (59, 131, and 216 g respectively) were lower (by 20 to 34%) than 2+ to 4+ rainbow trout in the Nation River (90, 171, and 269 g, respectively) (Fig. 21). Average length and weight of Mesilinka rainbow trout, age 5+ and 6+ were greater than those in the Nation River, however the numbers caught in the Nation River (3 and 2 fish, respectively) were too small to have sufficient confidence in these observations. Analysis of variance (ANOVA) was carried out on age 3+ rainbow trout caught in Blackpine (Control), T1 and T2 (Aug. 11 - 16, 1992). No significant difference ($p<0.05$) was found between the mean age 3+ lengths in the three reaches.

In 1992, average length-at-age of age 2+ to 4+ Mesilinka River Arctic grayling (195, 257 and 300 mm respectively) were lower (by 5 to 17%) than age 2+ to 4+ Arctic grayling in the Nation River (236, 281 and 317 mm, respectively) (Fig. 22). Average weight-at-age of age 2+

to 4+ Mesilinka grayling (113, 189 and 317 g, respectively) were also lower (by 20 to 40%) than age 2+ to 4+ Arctic grayling in the Nation River (185, 288 and 395 g, respectively) (Fig. 22). In both rivers, length and weight of age 5+ Arctic grayling were similar. Analysis of variance (ANOVA) was carried out on age 4+ Arctic grayling caught in Blackpine, T1 and T2. No significant difference ($p<0.05$) was found between the mean age 4+ lengths in the three reaches. A significant difference was detected when Nation River Arctic grayling were added to the analysis, however, time of sampling between the Mesilinka reaches (mainly August) and the Nation River (in July) hampers the comparison.

Average length-at-age of age 2+ to 4+ Mesilinka River rainbow trout (1993) were 161, 226 and 268 mm, respectively, and in the Nation River, 159, 232 and 268 mm, respectively, i.e., very similar (Fig. 23). Average weight-at-age of age 2+ to 4+ Mesilinka River rainbow trout (1993) were 70, 140 and 232 g, respectively, and in the Nation River, 70, 170 and 233 g, respectively. Average length-at-age of age 2+ to 4+ Mesilinka grayling (1993) were 185, 276 and 299 mm, respectively, and weight-at-age were 95, 211 and 305 g, respectively (Fig. 24). These values are similar to 1992 Mesilinka data. Insufficient numbers of Nation River grayling (9 specimens) were caught in 1993 to summarize length and weight measurements.

Overall there seems to be a slight tendency towards greater sizes and growth rates per year for rainbow trout and Arctic grayling in the Nation River, however, additional data is required before making any firm conclusions. If true it is likely due to warmer summer water temperatures and greater food abundance (benthic insects) in the Nation River.

Comparisons to other River Systems

are compared in Fig. 25. In comparing Arctic grayling length-at-age data from various rivers, the Nation and Mesilinka rivers contain higher values than those in the Parsnip (Anonymous 1978) and the Adsett river systems (Stewart et al. 1982) (Fig. 25). In the Sukunka River, where temperature is similar or slightly warmer than the Mesilinka River, size-at-age of Arctic grayling is less, but the population is more abundant (Stuart and Chislett 1979). Lake and river fisheries are not similar with respect to fish growth dynamics, however, for the sake of comparison, data were also included from Red Rock Lake, Montana (likely American grayling) (Nelson 1954) and the Williston Reservoir, 1974-75 (Barrett and Halsey 1985). Grayling in these two water bodies contain the highest length-at-age data.

Length-at-age (Fig. 26) and Weight-at-age (Fig. 27) of rainbow trout size from the Mesilinka and Nation rivers were compared to those in the upper Nechako River (1983 and 1986, in: Slaney 1986), the Bow River below Calgary (Courtney and Fernet 1990) and the Crowsnest River, flowing east out of the Rocky Mountains in southern Alberta (Alberta Fish and Wildlife Branch files, Lethbridge). The upper Nechako River was open to sports fishing through 1983, and closed thereafter. The Nechako is a northern river quite similar in geographic

character to the Mesilinka and Nation rivers but with an oligo-mesotrophic nutrient regime (Slaney et. al. 1984, Slaney 1986). Water temperatures in the upper Nechako River (data on file) during the summer are higher than those in the Mesilinka and similar, or a little higher than those in the Nation River (Slaney 1986). The Bow River below Calgary contains ideal rainbow trout habitat combined with a very high nutrient regime due to treated wastewater effluent being discharged by the city. Similarly, the Crowsnest River also receives treated municipal wastewater but to a lesser extent. Bow River mean monthly water temperature for August is in the 15-16 °C range (based on 1975 data, in Culp et al. 1992), which is similar to the Nation River. Climate and geography in the Bow and Crowsnest systems are similar to those of the Mesilinka and Nation rivers. Clearly, rainbow trout in the Mesilinka and Nation rivers are substantially smaller than those in the upper Nechako, Bow and Crowsnest rivers. Thus, the Nechako, Bow and Crowsnest river data are supportive of the potential of low level nutrient addition to enhance fish growth in cold water, oligotrophic, interior systems such as the Mesilinka and Nation rivers.

Fish Growth

Only twelve fish tagged in 1992 were recovered in 1993 (five rainbow trout, five Arctic grayling and two bull trout). Calculations of annual growth will be conducted in future years as more data accumulates.

Weight-to-Length Index of Condition

The following subsection on index of condition is provided as an introduction to the subject and will become more meaningful as additional data is collected in future years. According to Cone (1989), the log linear relationship between length and weight serves as suitable index of condition. For a given fish species, an increase in predicted weight for a given length (over space or time) would signify a positive index response, a decrease, a negative response. Differences between regressions are considered meaningful if there are either significant differences in the y-intercept, or the slope.

Length-weight regression variables (slope, y-intercept and level of significance) for select Mesilinka and Nation river fish species are provided in Table 3 together with predicted weights per size (calculated from the regression equations). Bow River data (from Courtney and Fernet 1991) has been added to the table for comparative purposes, and select regression graphs are provided in Fig. 28. In general, equations with a larger slope (and similar y-intercept values) indicate a higher index of condition and the fish heavier at a given length.

The benefit of calculating an index of condition is that a great volume of data can be compared quickly and in a relatively small amount of space. There are, however, limitations to its use based on variables such as time of sampling, and fish age. An example is provided in

Table 3, where the slope for Arctic grayling in the Mesilinka River 1993 changed depending on whether the regression was based on data from July through September, or just for a 12 day period in July. Condition will change on a seasonal basis with both adult and juvenile fish usually gaining weight for a given length during the growing season.

Including all lengths, of both juveniles and adults in a regression analysis affects the slope variable and thus the index of condition. In Table 3 this is apparent in a) the slope for rainbow trout in the Mesilinka tributaries 1993, which includes all sizes but mainly juveniles; b) for rainbow trout in the Mesilinka River 1993 where one calculation is based on ail sizes and another on fish > 100 mm; and c) for bull trout in the Mesilinka River 1993, where again, one calculation is based on ail sizes and another on fish > 100 mm. A second juvenile-adult example is found in Fig. 29, where rainbow trout 200 mm in length are predicted to weigh more in the Nation as compared to the Bow and Mesilinka rivers (10 - 20 g more); however, 400 mm fish would weigh more in the Bow River (100 g more). What the regression equations do not reveal is that 200 mm Bow River rainbow trout are between age 0+ and 1+, while 200 mm Mesilinka and Nation River rainbow trout are between age 2+ and 3+ (Fig. 29). To more rigorously compare regressions, samples should be taken during the same period over time and space, and be restricted either to juvenile or adult fish.

Fish Abundance Estimated by Underwater Census and Mark-Recapture

Generating fish abundance estimates requires a number of calculations. Tables 4 - 6 provide background data and steps used in determining Mesilinka River fish numbers; Tables 7 - 9 then provide best estimates of abundance. Table 4 provides the results of the 1992 and 1993 underwater census without correction factors applied. The results are based on the numbers of fish tallied by swimmers in each of two swims and then expanded to include those lanes which were not observed by swimmers, i.e. the in-between lanes (supporting data is provided in Appendix A, Tables A12 - A17). The expansion factor depends on the number of swimmers, the width of the river, and the underwater visibility present during the swim. Expanded counts (without correction factors applied) are limited to fish $\geq$20 cm (Table 5). This allows for direct comparison between the swim count results and the mark-recapture results where the mark-recapture was conducted by angling and therefore also restricted to catchable-sized fish (mainly $\geq$ 20 cm in length).

Mark-recapture results were used to develop correction factors for the underwater counts (Table 6). To be statistically valid, a mark-recapture procedure requires the initial marking of fish (M) to be 20% or more of the total estimated population (N), i.e., $M/N \geq 20\%$ (Vincent 1971). In addition, to avoid any bias due to low numbers, the total number of marked fish (M) multiplied by the number of captured (C) should be more than four times the total estimated population (N), i.e., $MC > 4N$; or $M + C$ should be $\geq N$ (Robson and Regier 1964). Based on these conditions, only two of the correction factors are valid, namely for rainbow trout in T2,

1992 (correction factor 3.2), and Arctic grayling in Blackpine, 1993 (correction factor of 2.2) (final column in Table 6). These correction factors appear to be reasonable. Rainbow trout have the larger correction factor as they are smaller than Arctic grayling, and tend to inhabit more protected areas, making them harder to see, and easier to miss, especially in some of the swifter and more log debris containing sections of the Mesilinka River. Arctic grayling are larger than the rainbow trout and tend to be found in more open water. By comparison, correction factors for underwater counts of cutthroat trout in the St. Mary River ranged from 1.35 to 1.9 between 1984 and 1986 (Slaney and Martin 1987, and data on file), while correction factors for counts of rainbow trout in the Nechako River (1985), a river with deep pools (i.e., some pools too deep to see to bottom), ranged from 2.9 to 3.9 (data on file).

Marking and recaptures of bull trout were less extensive than for rainbow trout and Arctic grayling and therefore a valid correction factor was not obtained. The most extensive results, however, were obtained in 1993. Based on these, a correction factor for bull trout probably lies between approximately 1.4 - 2.5. Underwater census of bull trout likely require the smallest correction factor of the three fish since bull trout are larger than both rainbow trout and Arctic grayling and therefore more visible. We have therefore applied a tentative correction factor of 2 to the bull trout data, however, this value ought to be confirmed in future mark-recapture testing.

Using the above correction factors, our best estimates of fish populations (per ha and per km) for Mesilinka fish $\geq$ 20 cm in length are provided in Table 7. In this table, mountain whitefish, squawfish and sucker species were also given correction factors of 2. These are based on comparison of fish sizes and are applied, as crude estimates only, to compare the various fish species recorded in the swim counts. However, any observations and conclusions based on these correction factors should be used elsewhere with caution. Additional accuracy in the abundance estimates could be achieved by calculating individual correction factors for different size categories within each fish species (small fish are harder to detect during snorkel swims than larger fish), if sample size were sufficient.

The total fish density (sum of all fish $\geq$ 20 cm) was higher in 1992 than 1993 (Table 7, Fig. 30). Mountain whitefish were the most numerous fish in all three reaches in both years (up to 81 whitefish/ha, 310 whitefish/km). Figure 31 provides the same data but without mountain whitefish and sucker species, in order to better illustrate the data for rainbow trout, Arctic grayling and bull trout. Rainbow trout in 1992 and 1993 were most numerous in Reach T2 (6.7 and 8 fish/ha, respectively), and least numerous in Blackpine (1.3 and 1.6 rainbow trout/ha, respectively). These values compare to 17 and 38 rainbow trout/ha in the Upper Nechako River in 1983 and 1986, pre- and post-sport fishery closure, respectively (Slaney 1986). Thus in comparing the two rivers there is a 2- to 30-fold difference in rainbow trout densities, depending on year and reach, with the upper Nechako River clearly more productive. Arctic grayling were most numerous in Reach T1 (7.5 and 4.4 fish/ha, respectively in 1992 and 1993), and bull trout

most numerous in Reach T2 (1.8 and 2.4 fish/ha, 7 and 9 fish/km, respectively). Suckers at times were about as numerous as rainbow trout, and most numerous in T2. Squawfish were rarely sighted. Overall salmonid densities (bull trout, rainbow trout and grayling, excluding mountain whitefish) in both years were higher in Tl and T2 (8 - 13 salmonids/ha) than in Blackpine (5-7 salmonids/ha), the proposed upstream control reach for fertilization. Between year variation could be due to factors such as variations in water temperature (cooler / warmer years); the impact of flows / turbidity on spawning and summer feeding behaviour, on overwintering conditions, and on fish movement in / out of the reservoir; and angling pressure.

The majority of catchable sized rainbow trout and mountain whitefish were in the 20-30 cm category, while the most frequent sizes for both Arctic grayling and bull trout were in the 30-40 cm category (Table 8). Bull trout were also present in lesser numbers, up to 70 cm in length.

Maximum standing crop (biomass per unit area) of rainbow trout in 1992 and 1993, occurred in T2 (1.6 and 2 kg ha^{-1}, respectively), and minimum standing crop in Blackpine (0.3 and 0.5 kg ha^{-1}, respectively) (Table 9, Fig. 32). These compare to 3.8 and 12 kg ha^{-1} in the Upper Nechako River, 1983 and 1986 (Slaney 1986) which is a 2- to 40-fold difference in standing crop between the two rivers.

Data quality is influenced by factors such as experience of the field crew (in angling, tagging, underwater census technique) and specific stream conditions during sampling (e.g., extent of turbidity, water temperature and flows). Flows during the 1993 underwater census were significantly higher (38 - 44 $m^3 s^{-1}$) than flows in 1992 (22 - 30 $m^3 s^{-1}$) (Fig. 33), and these may have affected the census tallies. However, the same snorklers were utilized in both years in the Mesilinka.

Hooking and tagging mortalities, and tag losses (Floy tags) occur in mark/recapture procedures. Hooking and tagging mortalities were estimated to be 11% for rainbow trout in one study on the Nechako River in which rainbow trout were held for four days in a pen after being caught by angling with the use of barbless hooks and bait (Slaney 1986). Tag loss was estimated to be 18% for grayling in an Alberta river, but this study occurred under severe conditions during spawning, where the fish were subject to abrasion on the stream bottom (Carl et al. 1992). Tag loss on steelhead trout in the Keogh River, over a period of 3 months (1976) was estimated to be 10% with inexperienced taggers, and 5% for experienced taggers (data on file). Fish tag losses at the Mesilinka River in 1992 and 1993 were likely small since the period between tagging and recapture in both years was only a few weeks. Arbitrarily incorporating 10% hooking and tagging mortalities and 10% tag loss into the Mesilinka mark-recapture calculations would reduce the size of the correction values by approximately 5 to 15%.

Mesilinka Tributaries

Fish Presence and Size at Age

Mesilinka River tributaries were sampled by electrofishing and with fish traps. Sparse numbers of juvenile rainbow trout were captured in the net traps (Table 10), while bull trout and whitefish were more evident. Most juvenile rainbow trout probably moved towards the river earlier in the season, prior to initiation of the net trapping in late July. Arctic grayling were found only three times in all the tributary sampling, and in sparse numbers, while electrofishing in Carina Creek (3 grayling) August 1992; and in Culvert (2 grayling) and Control (1 grayling) creeks, September 1993, all less than 20 cm in length. Arctic grayling may move out of the tributaries prior to initiation of fish sampling activities (before late July), or possibly they remain in the mainstem. Juvenile Arctic grayling were found in the mainstem just above T1, and in sidechannels of the Mesilinka mainstem (Reach T2) during electrofishing in late August 1993 (refer back to Table 1). Numerous sucker fry were caught in Carina Creek, and one burbot was caught in Culvert Creek (Aug. 1992). Sculpin, chub, and other minnow species are also known to be present in these streams.

Length- and weight-at-age of age 0+ to 2+ rainbow trout varied greatly depending on location and time of sampling (Table 11 and 12). There was a 2- to 3-fold difference in weight amongst age 1+ rainbow trout. Age 1+ fish in Control and Culvert creeks appear in better condition (larger size at a given date) than in Gopherhole Creek, however, caution is necessary when interpreting age data based on limited numbers of fish.

Fish Species Abundance

Mark-recapture results, 1992 and 1993, are provided in Table 13. Based on mark-recapture requirements for statistical validity (described previously), unbiased population estimates are highlighted in bold print in the table. Valid estimates (100 m sections only) are available for rainbow trout, bull trout and mountain whitefish in Gopherhole and Control creeks, 1992; and for rainbow trout in Carina Creek, 1993 (Fig. 34). Lake-headed Carina Creek appears to be inhabited by negligible numbers of young fish (other than rainbow trout) in late-August to September. Beaver dams may have induced an earlier downstream migration, and thus confounded the sampling of this stream which appears to have a high potential for juvenile recruitment to the mainstem.

The relative abundances of fish in Gopherhole and Control creeks, based on Catch-per-unit effort (CPUE) in late August, 1993 (Table 14, Fig. 35), compare quite favourably to the mark-recapture derived relative abundances of 1992 in early September (Fig. 34). Bull trout were the most numerous species present in Culvert and Control creeks, rainbow trout were most numerous in Gopherhole and Fatfish creeks, and mountain whitefish most numerous in Culvert

Creek, at Site 2. Similar to the electrofishing results in the tributaries, electrofishing Mesilinka side channels (in T2 only, 1993) produced few Arctic grayling. Juvenile rainbow trout were most numerous, followed by mountain whitefish, bull trout and grayling.

Fish productivity in each of the tributaries (and mainstem sidechannels) depends on a variety of factors such as stream flow, temperature and nutrient levels, as well as extent of instream and bankside cover, stream substrate characteristics and other habitat indices. Insufficient data exists to accurately predict fish productivity in the Mesilinka tributaries (or mainstem sidechannels).

Additional fertilization of the tributaries should increase juvenile recruitment to the mainstem. A shift to slow release fertilizers currently being tested for dissolution rates (at the MELP Research Hatchery, Abbotsford) should increase efficiency because the drip systems such as those used in 1993 require too frequent adjustment at the low rates of delivery (0.2 L/min).

Mesilinka Embayment

A limited sampling program was conducted in 1992 in the Mesilinka embayment (Omineca arm of Williston Reservoir) (Table 15). Based on the limited data set, age 3+ rainbow trout were larger in the embayment (average length 260 mm) than in the Mesilinka mainstem and Nation rivers (average length 216 - 232 mm). Similarly, rainbow trout caught in the Williston Reservoir in 1974 and 1975 were larger than in the river (average length 295 mm, in Barrett and Halsey 1985). Bull trout caught by angling (1993) were also larger in the embayment (median length 640 mm) than the river (median length 328 mm).

Migratory adfluvial (lacustrine) stocks in the embayment area may benefit from the proposed river fertilization project because of stimulation of the riverine food chain and resultant spiralling of nutrients downstream to the embayment. Results of this kind were found with small-scale nutrient treatment at a stream and embayment at a northern Swedish reservoir, where increased zooplankton and benthic fauna benefited Arctic char and European grayling, respectively (Milbrink and Holmgren 1981). In addition, attraction of rainbow and bull trout into the Mesilinka River from the embayment could be substantial based on the Milbrink and Holmgren (1981) study. The size of some of the larger bull trout (3-5 kg) caught in the Mesilinka River in 1992-93 suggests they spend the winter to spring months in the reservoir, similar to adult bull trout and rainbow trout in the Skagit River-Ross Reservoir system in southern B.C.

FEASIBILITY AND RECOMMENDATIONS

Results of field work in 1992-93 confirm the suitability of the Mesilinka River for whole-river fertilization. The Mesilinka River contains sufficient flow and abundant adult rearing habitat. Water temperatures are low but within the acceptable range for salmonid growth, and water quality is good. Turbidity and suspended sediment levels can persist into mid-July, but transparency (more than 1m) appears to be sufficient to start river fertilization in late June to early July. Suitable juvenile fish habitat is available in the tributaries and in the side channels of the mainstem. Desirable angling sites, and points of access are both present.

Contrary to initial expectations, the Mesilinka River is not only phosphorous limited, but also appears to be nitrogen limited albeit to a lesser degree. Nitrogen addition, together with the required phosphorous, should be carried out for the foreseeable future, until a larger database of water quality is built up. Additional fertilization of Gopherhole and Culvert creeks, to increase their use as juvenile salmonid nursery streams, will also require nitrogen.

Underwater counts indicate the Mesilinka River has sufficient numbers of rainbow trout, Arctic grayling, bull trout and mountain whitefish (up to 31, 31, 9 and 310 fish/km, respectively) to proceed with fertilization. Based on capture methods used, most catchable-sized rainbow trout and Arctic grayling are small and less than 30 cm.

Larger rainbow trout captured in the Mesilinka River were up to 38 cm (500 g) in length, and larger Arctic grayling up to 40 cm (700 g). This data provides some evidence that rainbow trout and Arctic grayling are capable of growing to medium and possibly large size at the temperature regime of the Mesilinka River. Based on fish size data from other rivers, in particular from the upper Nechako, Sukunka and Bow rivers, a numerical response, and/or a growth response of rainbow trout and Arctic grayling to riverine fertilization should become evident, although the magnitude is unclear. Improvement in productivity of Mesilinka side-channels, where juvenile fish rear (including Arctic grayling), will likely occur as a result of fertilization.

Mesilinka River tributaries also contain significant numbers of juvenile rainbow trout and bull trout. Stimulation of the nutrient limited "nursery tributaries" with fertilizer, as carried out in 1993, should augment recruitment of juvenile fish. The very low rates of fertilization required in the tributaries strongly recommends the use of newly developed slow-release solid fertilizer as an improvement over the currently used gravity-flow based system of dispensing liquid fertilizer.

Fertilizer-initiated downstream spiralling of nutrients, and subsequent attraction of forage and sportfish from the reservoir are expected to occur. Large-sized bull trout caught in the river and the embayment (up to 81 cm and 5.2 kg) suggest that some level of migration already occurs.

Biophysical and fisheries data will continue to be gathered in 1994 through 1996. Based on current and future data, documentation of the magnitude of increases in fish productivity (growth and numbers) resulting from Mesilinka fertilization will be realized. The results will allow for long term river management planning for the Mesilinka River, and for application to other cold water, oligotrophic interior systems, including the Nation River.

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TABLES

Table 1. Mesilinka and Nation rivers, fish tally, 1992-93.

River	Sampling method	Date	Rainbow trout	Bull trout	Arctic grayling	Mountain whitefish	Other species
1992							
Nation R.	Angling	9-Jul	12	-	-	-	-
Nation R.	Angling	16-23 Jul	25	1	85	-	-
Mesilinka R.	Angling	Jul-Aug	188	55	104	8	-
1993							
Nation R.	Angling	13-16 Jul	120	3	9	1	
Mesilinka R.	Angling	Jul-Sep	135	29	70	7	
	Electrofishing	Aug-Sep	55	17	14	16	- 8 burbot - 4 minnows - 1 sucker
Mesilinka R. sidechannel, T2	Electrofishing	Late Aug	28	8	5	12	- 3 chub - 1 sculpin - 4 suckers

- electrofishing yielded mainly juveniles.
- in addition to the above species, 4 squawfish were observed during the Mesilinka R. underwater census, 1993
- burbot sizes ranged from 90 - 270 mm
- tally reflects capture methods used, not actual or relative numbers in the river

Table 2. Fish lengths and weights, Mesilinka and Nation river salmonids, 1992-93.

Species	Sampling Method	# fish	Median length (mm)	Maximum length (mm)	Median weight (g)	Maximum weight (g)
1992						
	Mesilinka River					
Rainbow trout	Angling	188	233	356	170	511
Arctic grayling	Angling	104	304	395	340	681
Bull trout	Angling	55	379	810	539	4593
Mt. whitefish	Angling	8	269	312	213	397
	Nation River					
Rainbow trout	Angling	37	246	314	210	465
Arctic grayling	Angling	85	300	349	330	510
1993						
	Mesilinka River					
Rainbow trout	Angling	135	248	384	170	511
Arctic grayling	Angling	70	295	382	312	596
Bull trout	Angling	29	328	670	291	2807
Mt. whitefish	Angling	7	270	339	142	340
Rainbow trout	Electrofish	55	43	168	1	49
Arctic grayling	Electrofish	14	59	74	1.9	3.4
Bull trout	Electrofish	17	83	211	6.9	71
Mt. whitefish	Electrofish	16	48.5	56	0.8	1.6
	Nation River					
Rainbow trout	Angling	120	242	340	190	350
Arctic grayling	Angling	9	232	290	140	300

Table 3. Length-weight regression analyses.

Fish spec.	Location	Year	Sampling Period	# fish (n)	Regression equation: Slope	y-intercept	Predicted weight (g): /200 mm	/250 mm	/350 mm	/450 mm	/550 mm	/650 mm	r2	Signif (p<)	Comments
Rbt	Mes. trib's	93	Aug-Sep	79	3.207	-5.319	107.3	219.4	645.3	-	-	-	0.97	0.05	- mostly aged 0+ to 1+
Rbt	Mesilinka R.	92	Jul 2-Aug 16	187	2.708	-4.230	98.2	179.7	447.0	882.9	-	-	0.88	0.05	- all fish > 100 mm
Rbt	Nation R.	92	July 9-21	47	2.369	-3.356	124.5	211.2	468.7	850.1	-	-	0.85	0.05	- all fish > 100 mm
Rbt	Mesilinka R.	93	Jul - Sep	121	2.586	-3.937	103.1	183.7	438.5	839.9	-	-	0.98	0.05	- all fish > 100 mm
Rbt	Mesilinka R.	93	Jul - Sep	145	2.958	-4.820	96.9	187.5	507.4	1067.1	-	-	0.98	0.05	- all sizes, to cf above
Rbt	Nation R.	93	Jul 13-16	103	2.590	-3.973	108.8	193.9	463.6	888.8	-	-	0.82	0.05	- all fish > 100 mm
Rbt	Bow R., AB	90	End Aug.	689	2.754	-4.300	108.9	201.3	508.6	1016.1	-	-	0.97	0.05	- below Calgary, >100 mm fish
Rbt	Bow R., AB	88	Sep-Oct	2355	2.774	-4.342	109.9	204.1	519.1	1042.3	-	-	0.98	0.05	- below Calgary, >100 mm fish
Gr	Nation R.	92	Jul 9-21	85	2.693	-4.146	112.4	205.0	507.2	-	-	-	0.87	0.05	- all fish > 100 mm
Gr	Nation R.	93	Jul 13-16	8	2.823	-4.501	98.4	184.7	477.3	-	-	-	0.97	0.05	- only 8 fish
Gr	Mesilinka R.	92	Jul 2-Aug 16	104	2.764	-4.366	98.6	182.8	463.2	-	-	-	0.90	0.05	- all fish > 100 mm
Gr	Mesilinka R.	93	Jul - Sep	59	2.286	-3.203	113.8	189.5	409.0	-	-	-	0.88	0.05	- all fish > 100 mm
Gr	Mesilinka R.	93	Jul 18-29	17	2.399	-3.363	114.1	194.8	436.7	-	-	-	0.90	0.05	- limited dates, to cf above
BT	Mesilinka R.	92	Jul 3-Aug 16	55	2.821	-4.571	83.2	156.2	403.5	819.8	1444.0	2313.3	0.95	0.05	- all fish > 100 mm
BT	Mesilinka R.	93	Jul - Sep	37	2.948	-4.934	72.3	139.7	376.6	790.1	1427.5	2336.0	0.97	0.05	- all fish > 100 mm
BT	Mesilinka R.	93	Jul - Sep	46	2.832	-4.626	77.7	146.2	379.1	772.5	1363.7	2188.6	0.98	0.05	- all sizes, to cf above
MWF	Mesilinka R.	92	Jul 3-Aug 16	8	3.876	-7.104	65.4	155.4	572.5	-	-	-	0.89	0.05	- only 8 fish
MWF	Mesilinka R.	93	Jul - Sep	7	2.520	-3.923	74.9	131.5	306.9	-	-	-	0.80	0.05	- only 7 fish

- Regression equation is in log-log format: y=10^(slope(log(x)) + y-intercept); x = length, y = weight
- Predicted weight: predicted weight (g) of a 200 mm, 250 mm (fork length) fish and up to 650 mm, based on regression equation.
- Predicted weights for rbt, gr and MWF restricted to lengths of less than 450 mm, as per fish sampling results.
- signif. (p<) refers to significance of the slope of the equation.
- Rbt, rainbow trout; Gr, Arctic grayling; BT, bull trout; MWF, mountain whitefish.
- Mes. trib's: Mesilinka tributaries; cf: compare.
- Mesilinka tributary equation based on sampling later in season and with more juvenile rbt than other rbt samples.
- sampling date (season) and extent of juvenile fish will influence slope and y-intercept values of calculated equations.
- all fish > 100 mm unless otherwise stated.

Table 4. Mesilinka River expanded swim counts, 1992, and 1993, total fish densities.

# fish	Rainbow trout		Arctic grayling		Bull trout		Sucker species		Mountain whitefish		Squawfish		Total rbt, gr and bt	
per:	/ha	/km	/ha	/km	/ha	/km	/ha	/km	/ha	/km	/ha	/km	/ha	/km
1992														
Blkp	0.5	1.8	2.6	9.8	0.2	0.7	1.9	7.1	40.4	151.8	0	0	3.3	12.4
t1	1.5	6.0	3.6	14.7	0.8	3.1	0.9	3.5	38.0	155.1	0	0	5.8	23.8
t2	2.8	10.9	2.1	8.0	1.0	3.7	5.3	20.7	9.5	36.7	0	0	5.8	22.6
1993														
Blkp	1.1	4.0	1.4	5.3	0.3	1.0	0.4	1.6	21.3	80.0	0	0	2.8	10.4
t1	1.9	7.9	3.0	12.1	0.5	2.1	0.6	2.3	13.7	56.0	0	0	5.4	22.1
t2	3.8	14.8	1.7	6.5	1.3	4.9	2.2	8.6	11.8	45.5	0.2	0.7	6.8	26.1

- Based on reach lengths of 7.5, 7.2, 8.1 km, for Blackpine (control), T1, and T2, respectively, and average widths in August.
- Each value is based on an average of two swims. Rbt, rainbow trout; gr, Arctic grayling; bt, bull trout.
- Total counts for each swim were obtained by expanding the mid lane counts & adding the shore lane counts.
- Blkp, Blackpine (control reach).

Table 5. Mesilinka River expanded swim counts, 1992, and 1993, fish equal and > 20 cm.

# fish	Rainbow trout		Arctic grayling		Bull trout		Sucker species		Mountain whitefish		Squawfish		Total rbt, gr & bt	
per:	/ha	/km	/ha	/km	/ha	/km	/ha	/km	/ha	/km	/ha	/km	/ha	/km
1992														
Blkp	0.5	1.8	2.5	9.5	0.2	0.7	1.9	7.1	40.4	151.8	0	0	3.1	11.9
t1	1.4	5.8	3.4	13.9	0.8	3.1	0.9	3.5	38.0	155.1	0	0	5.6	22.8
t2	2.1	8.1	1.3	5.2	0.9	3.7	5.3	20.7	9.5	36.7	0	0	4.3	17
1993														
Blkp	0.5	1.7	1.4	5.3	0.3	0.9	0.4	1.6	11.3	42.4	0	0	2.1	7.9
t1	1.1	4.6	2.0	8.2	0.4	1.5	0.6	2.3	8.9	35.0	0	0	3.5	13.8
t2	2.5	9.6	1.1	4.2	1.2	4.6	2.2	8.6	5.0	19.0	0.2	0.7	4.8	18.4

- Based on reach lengths of 7.5, 7.2, 8.1 km, for Blackpine (control), T1, and T2, respectively, and average widths in August.
- Each value is based on an average of two swims. Rbt, rainbow trout; gr, Arctic grayling; bt, bull trout.
- Total counts for each swim were obtained by expanding the mid lane counts & adding the shore lane counts.
- Mt whitefish in Blackpine 1993 calculated based on average of equal and > 20 cm fish in totals of T1 and T2 (*53%).
- Blkp, Blackpine (control reach).

Table 7. Mesilinka R. expanded swim counts, plus correction factors applied, 1992-93, fish equal and > 20

Corr. factor:	Rainbow trout 3.2		Arctic grayling 2.2		Bull trout (assume 2.0)		Sucker species (assume 2.0)		Mountain whitefish (assume 2.0)		Squawfish (assume 2.0)		Total rbt, gr & bt (sum)	
# fish per	/ha	/km	/ha	/km	/ha	/km	/ha	/km	/ha	/km	/ha	/km	/ha	/km
1992														
Blkp	1.3	4.5	5.5	20.9	0.4	1.4	3.8	14.2	80.8	303.6	0	0	7.2	26.8
t1	4.5	18.6	7.5	30.6	1.7	6.2	1.8	7.0	76.0	310.2	0	0	13.6	55.3
t2	6.7	25.9	2.9	11.4	1.8	7.4	10.6	41.4	19.0	73.4	0	0	11.4	44.8
1993														
Blkp	1.6	5.4	3.1	11.7	0.6	1.6	0.8	3.2	22.6	84.8	0	0	5.3	18.7
t1	3.5	14.7	4.4	18.0	0.8	3.0	1.3	4.6	17.2	70.0	0	0	8.7	35.8
t2	8.0	30.7	2.4	9.2	2.4	9.2	4.5	17.2	10.0	38.0	0.3	1.4	12.8	49.2

- Based on reach lengths of 7.5, 7.2, 8.1 km, for Blackpine (control), T1, and T2, respectively, and average widths in August.
- Each value is based on an average of two swims. Rbt, rainbow trout; gr, Arctic grayling; bt, bull trout.
- Total counts for each swim were obtained by expanding the mid lane counts & adding the shore lane counts.
- Mt whitefish in Blackpine 1993 calculated based on average of equal and > 20 cm fish in totals of T1 and T2 (*53%).
- Correction factors for rainbow trout and Arctic grayling are based on valid mark-recapture estimates.
- Correction factors for bull trout are based on partially valid mark-recapture estimates; use with caution.
- Correction factors for mt. whitefish, suckers and squawfish are estimates only; use with caution.
- Blkp, Blackpine (control reach); corr. factor, correction factor.

Table 8. Mesilinka River expanded swim counts, 1992-93, fish densities by size category, number of fish per ha.

Length	Rainbow trout				Arctic grayling				Bull trout						Mountain whitefish			
(cm):	20-30	30-40	40-50	total	20-30	30-40	40-50	total	20-30	30-40	40-50	50-60	60-70	total	20-30	30-40	40-50	total
(a) Expanded, but without correction factors (# fish / ha)																		
1992																		
Blackpine	0.2	0.1	0	0.3	0.6	1.8	0.1	2.5	0	0.1	0.04	0.05	0.03	0.22	-	-	-	40.4
t1	0.7	0.7	0.03	1.43	1.3	1.9	0.2	3.4	0.2	0.3	0.2	0.05	0.02	0.77				38.0
t2	1.6	0.5	0	2.1	1	0.3	0	1.3	0.2	0.4	0.3	0.1	0	1				9.5
total	2.5	1.3	0.03	3.83	2.9	4	0.3	7.2	0.4	0.8	0.54	0.2	0.05	1.99	0	0	0	87.9
1993																		
Blackpine	0.3	0.2	0	0.5	0.2	1.1	0.1	1.4	0.04	0.1	0.02	0.05	0.03	0.24	-	-	-	21.3
t1	1	0.1	0.03	1.13	0.9	1.1	0.1	2.1	0.1	0.2	0.1	0	0.05	0.45	6.1	2.2	0.2	8.5
t2	2	0.5	0.03	2.53	0.9	0.2	0	1.1	0.2	0.4	0.2	0.1	0.2	1.1	3.9	1.1	0.1	5.1
total	3.3	0.8	0.06	4.16	2	2.3	0.2	4.6	0.34	0.7	0.32	0.15	0.28	1.79	10	3.3	0.3	34.9
(b) Expanded, and with correction factors applied (# fish / ha)																		
1992																		
Blackpine	0.64	0.32	0	0.96	1.32	3.96	0.22	5.50	0	0.20	0.08	0.1	0.06	0.44	-	-	-	80.8
t1	2.24	2.24	0.096	4.58	2.86	4.18	0.44	7.48	0.40	0.60	0.40	0.1	0.04	1.54				76.0
t2	5.12	1.60	0	6.72	2.20	0.66	0	2.86	0.40	0.80	0.60	0.2	0	2.00				19.0
total	8.00	4.16	0.096	12.26	6.38	8.8	0.66	15.84	0.80	1.60	1.08	0.4	0.10	3.98	0	0	0	175.8
1993																		
Blackpine	0.96	0.64	0	1.60	0.44	2.42	0.22	3.08	0.08	0.20	0.04	0.1	0.06	0.48	-	-	-	42.6
t1	3.20	0.32	0.096	3.62	1.98	2.42	0.22	4.62	0.20	0.40	0.20	0	0.10	0.90	6.1	2.2	0.2	17.0
t2	6.40	1.60	0.096	8.10	1.98	0.44	0	2.42	0.40	0.80	0.40	0.2	0.40	2.20	3.9	1.1	0.1	10.2
total	10.56	2.56	0.192	13.31	4.40	5.28	0.44	10.12	0.68	1.4	0.64	0.3	0.56	3.58	10	3.3	0.3	69.8

- based on reach lengths of 7.5, 7.2, 8.1 km, for Blackpine (control), t1, and t2, respectively and August widths, each value based on average of two swims.
- total counts for each swim were obtained by expanding the mid lane counts & adding the shore lane counts, and applying correction factors.
- Mountain whitefish in 1992 were counted only as equal or more than 20 cm and not by separate length categories.
- Mt whitefish (equal and > 20 cm) in Blackpine 1993 was calculated based on average percentage of equal and > 20 cm fish in totals of t1 and t2 (53%).
- correction factors for rainbow trout (3.2) and Arctic grayling (2.2) are based on valid mark-recapture estimates.
- correction factor for bull trout (2.0) is based on partially valid mark-recapture estimates, use with caution.
- correction factor for mountain whitefish (2.0) is estimate only; use with caution.
- table limited to fish equal and more than 20 cm in length since these are considered to be of angling size.

Table 9 Mesilinka River estimated standing crop of salmonids (kg/ha) equal and > 20 cm, based on expanded swim counts, and correction factors applied, 1992-93

Length	Rainbow trout				Arctic grayling				Bull trout						Mountain whitefish			
(cm):	20-30	30-40	40-50	total	20-30	30-40	40-50	total	20-30	30-40	40-50	50-60	60-70	total	20-30	30-40	40-50	total
1992																		
Blackpine	0.12	0.14	0.00	0.26	0.24	1.83	0.20	2.28	0.00	0.08	0.07	0.14	0.14	0.43	-	-	-	10.45
t1	0.40	1.00	0.08	1.49	0.52	1.94	0.41	2.87	0.06	0.24	0.33	0.14	0.09	0.87	-	-	-	9.83
t2	0.92	0.72	0.00	1.64	0.40	0.31	0.00	0.71	0.06	0.32	0.49	0.29	0.00	1.17	-	-	-	2.46
total	1.44	1.86	0.08	3.38	1.17	4.08	0.61	5.85	0.12	0.65	0.89	0.58	0.23	2.46	-	-	-	22.73
1993																		
Blackpine	0.18	0.28	0.00	0.46	0.08	0.99	0.16	1.23	0.01	0.08	0.03	0.14	0.14	0.40	-	-	-	5.51
t1	0.59	0.14	0.08	0.81	0.38	0.99	0.16	1.52	0.03	0.15	0.16	0.00	0.23	0.57	6.10	2.20	0	2.20
t2	1.18	0.70	0.08	1.96	0.38	0.18	0.00	0.56	0.06	0.30	0.32	0.29	0.93	1.89	3.90	1.10	0	1.32
total	1.94	1.12	0.16	3.22	0.83	2.16	0.32	3.31	0.09	0.53	0.51	0.43	1.31	2.86	10.00	3.30	0	9.03

- based on reach lengths of 7.5, 7.2, 8.1 km, for Blackpine (control), T1, and T2, respectively and August widths; each value based on average of two swims
- total counts for each swim were obtained by expanding the mid lane counts & adding the shore lane counts, and applying correction factors
- Mountain whitefish in 1992 were counted only as equal or more than 20 cm and not by separate length categories
- Mt whitefish (equal and > 20 cm) in Blackpine 1993 was calculated based on average percentage of equal and > 20 cm fish in totals of T1 and T2 (53%)
- correction factors for rainbow trout (3.2) and Arctic grayling (2.2) are based on valid mark-recapture estimates
- correction factor for bull trout (2.0) is based on partially valid mark-recapture estimates, use with caution
- correction factor for mountain whitefish (2.0) is estimate only, use with caution
- mean weights calculated from individual regression equations for both 1992 and 1993, respectively for rainbow trout, Arctic grayling and bull trout
- mean weight of 250 mm individual in 1993 (1993 regression equation) only used for mountain whitefish
- table limited to fish equal and more than 20 cm in length since these are considered to be of angling size

Table 10. Mesilinka tributaries, tally of number of fish caught, 1992-93.

	Rainbow trout	Bull trout	Arctic grayling	Mountain whitefish
		1992		
Electrofishing (Aug 20-22)				
Carina Creek	4	-	3	2
Control Creek	10	4	-	15
Culvert Creek	8	9	-	6
Gopherhole Creek	11	9	-	-
Tutizzi River	6	-	-	-
Fish trap (late Jul - early Sept.)				
Carina Creek	-	-	-	1
Control Creek	4	26	-	10
Culvert Creek	8	16	-	20
Gopherhole Creek	6	54	-	16
Electrofishing (Sept. 6)				
Control Creek	10	4	-	5
Culvert Creek	9	4	-	3
Gopherhole Creek	6	3	-	5
		1993		
Electrofishing (end August)				
Control Creek - total	4	56		12
Control Creek, Site 1	2	14		7
Control Creek, Site 2	2	42		5
Culvert Creek - total	13	34		25
Culvert Creek, Site 1	3	13		1
Culvert Creek, Site 2	10	21		24
Gopherhole Creek	27	9		4
Fatfish Creek	12	-		-
Grafton's Creek	3	-		7
Fish trap (late Jul - Aug)				
Control Creek	2	3		2
Culvert Creek	-	4		2
Gopherhole Creek	-	1		-
Electrofishing (mid-Sep)				
Carina Creek	19	-		1
Control Creek	1	32	1	3
Culvert Creek	3	10	2	13
Gopherhole Creek	10	7	-	-

- Sites 1 are upstream of the respective bridges across Control and Culvert creeks.
- Sites 2 are downstream of the respective bridges across Control and Culvert creeks.
- In Aug. 1992 electrofishing, numerous sucker fry were caught in Carina Cr., & one burbot in Culvert Cr.
- all sampling in Culvert Creek in 1992 occurred above the bridge.
- mink predation was a problem at at least one fish trap in 1992
- tally biased towards season and capture methods used (especially with the fish trap).

Table 11. Rainbow trout, length and weight data (age 1+ only), Mesilinka tributaries, 1992.

Location	Date	age (y)	# fish	Average length (mm)	Standard Error (SE) length (mm)	Average weight (g)	Standard Error (SE) weight (g)
Carina Cr.	20-Aug	1+	2	79.0	20.0	6.9	3.9
Control Cr.	20-Aug	1+	10	87.5	2.6	8.8	0.8
Culvert Cr.	20-Aug	1+	5	91.4	5.5	9.3	2.2
Gopherhole Cr.	22-Aug	1+	9	78.2	4.8	6.1	1.5
Control Cr.	6-Sep	1+	7	85.6	2.4	11.2	0.5
Culvert Cr.	6-Sep	1+	7	86.4	5.8	9.7	1.6
Gopherhole Cr.	6-Sep	1+	5	78.0	3.6	5.0	0.7
Tutizzi R.	7-Sep	1+	4	106.0	3.5	15.1	1.4

Table 12. Rainbow trout, length and weight data (ages 0+ - 2+), Mesilinka tributaries, 1993.

Location	Date	age (y)	# fish	Average length (mm)	Standard Error (SE) length (mm)	Average weight (g)	Standard Error (SE) weight (g)
Carina Cr.	15-Sep	0+	10	57.5	1.5	2.1	0.2
Gopherhole Cr.	31-Aug	0+	5	66.2	6.6	3.5	0.8
Culvert Cr.	28-Aug	1+	3	92.0	7.0	9.9	2.3
Fatfish Cr.	1-Sep	1+	2	96.0	11.0	8.8	1.4
Control Cr.	25-Jul	2+	2	107.0	17.0	16.8	6.5
Control Cr.	28-Aug	2+	2	150.0	9.0	43.1	9.8

Table 13. Mark-recapture results obtained by electrofishing, Mesilinka tributaries 1992-93.

Tributary	Fish species	Total marked M	Total captured C	Total cap. w/ mark R	Total fish N	Effic. rate R/C %	Minimum number MIN (%)	Significance tests M+C	MC	4N	Ave width (m)	No. fish per m2
1992 (early September)												
Gopherhole Cr.	rbt	16	6	4	**24**	67	**67**	22	**96**	**95**	3.4	**0.07**
(100 m section)	bull trout	2	3	2	**4**	67	**50**	**5**	6	16		**0.01**
	mt wt fish	3	5	3	**6**	60	**50**	**8**	15	24		**0.02**
Culvert Cr.	rbt	7	9	2	**27**	22	**26**	16	63	107	3	
(100 m section)	bull trout	9	4	1	**25**	25	**36**	13	36	100		
	mt wt fish	3	3	1	8	33	**38**	6	9	32		
Control Cr.	rbt	9	10	8	**12**	80	**74**	19	**90**	**49**	3.8	**0.03**
(100 m section)	bull trout	13	4	4	**14**	100	**93**	17	52	56		**0.04**
	mt wt fish	5	5	4	**7**	80	**69**	10	25	29		**0.02**
1993 (late August - early September)												
Gopherhole Cr.	rbt	6	5	1	21	20	**29**	11	30	84	5.6	
(100 m section)	bull trout	10	7	3	22	43	**45**	17	70	88		
Culvert Cr.	rbt	3	16	2	23	13	13	19	46	91	6	
(100 m section)	bull trout	7	5	2	16	40	**44**	12	35	64		
	mt wt fish	5	11	3	18	27	**28**	16	55	72		
	grayling	2	0	0	n/a	n/a	n/a	n/a	n/a	n/a		
Control Cr.	rbt	6	1	0	n/a	n/a	n/a	n/a	n/a	n/a	5.8	
(100 m section)	bull trout	11	15	2	64	13	17	26	165	256		
	mt wt fish	1	2	0	n/a	n/a	n/a	n/a	n/a	n/a		
	grayling	1	1	1	n/a	n/a	n/a	n/a	n/a	n/a		
Canoe Cr.	rbt	5	16	2	**17**	13	**29**	**21**	**80**	**68**	6	**0.02**
(100 m section)	bull trout	0	0	0	n/a	n/a	n/a	n/a	n/a	n/a		
	mt wt fish	0	1	0	n/a	n/a	n/a	n/a	n/a[2]	n/a		
	grayling	0	0	0	n/a	n/a	n/a	n/a	n/a	n/a		

- rbt, rainbow trout; mt wt fish, Mountain whitefish; grayling, Arctic grayling.

- n/a, too few results to follow through with any calculations.

- Effic. rate = catchability efficiency rate.

- Total fish N = (M+1)(C+1)/(R+1).

- Tl. recap. w/ mark: total no. of fish recaptured with mark (tag).

- MIN = % of total population that was marked. The minumum number to mark is 20% where the population (N) is less than 1000 (Vincent, 1971).

- for a mark/recapture to provide an unbiased estimate, MC should be > 4N, or M+C equal or >N (Robson and Regier 1964).

- numbers in bold are significant based on MIN > 20%, and MC > 4N, or M+C equal or >N.

- no reduction in mark-recapture population has been made for tagging losses or hooking mortalities in this project.

- all sampling in Culvert Creek in 1992 occurred above the bridge.

- average widths based on 10 measurements in each creek at time of fish sampling.

- results based on only one 100 m section electrofished in each stream.

- bull trout in Gopherhole Cr. (1992) included two > 20 cm in length.

- Mountain whitefish in Gopherhole Cr. (1992) are >20 cm in length.

- all other fish sampled (captured by electrofishing) were less than 20 cm in length, and most were less than 10 cm.

Table 14. Mesilinka tributaries, catch-per-unit-effort, 1993.

	# fish				E-fishing	CPUE (# fish/min)			
	Rainbow trout	Bull trout	Arctic grayling	Mountain whitefish	duration (seconds)	Rainbow trout	Bull trout	Arctic grayling	Mountain whitefish
Electrofishing (end August)									
Control Cr - total	4	56	-	12					
Control Cr., Site 1	2	14	-	7	643	0.2	1.3	-	0.7
Control Cr., Site 2	2	42	-	5	1029	0.1	2.4	-	0.3
Culvert Cr - total	13	34	-	25					
Culvert Cr., Site 1	3	13	-	1	509	0.4	1.5	-	0.1
Culvert Cr., Site 2	10	21	-	24	1612	0.4	0.8	-	0.9
Gopherhole Creek	27	3	-	4	1135	1.4	0.2	-	0.2
Fatfish Creek	12	-	-	-	530	1.4	-	-	-

- Sites 1 are upstream and Sites 2 are downstream of the respective bridges across Control and Culvert creeks.

- E-fishing duration, the amount of time spent electrofishing at a given site.

- CPUE, Catch-per-unit-effort.

Table 15. Fish length and weights, Mesilinka embayment, Omineca Arm, 1992-93.

Date	Sampling method	fish species	# fish	Average length (mm)	Standard Error (SE) length (mm)	Average weight (g)	Standard Error (SE) weight (g)
3-5 Jul '92	gill-netting	RBT age 3+	5	260	7	164	10
3-5 Jul '92	gill-netting	RBT age 4+	2	277	38	246	104
3-5 Jul '92	gill-netting	RBT age 5+	2	333	1	312	0

				Median length (mm)	Maximum length (mm)	Median weight (g)	Maximum weight (g)
3-5 Jul '92	gill-netting	BT	6	320	405	300	539
21 Aug '93	angling	BT	5	640	810	2892	5160

- median was used for bull trout as a better measure of the mean since the fish were not already divided by size based on age cate

- BT, bull trout; RBT, rainbow trout.

FIGURES

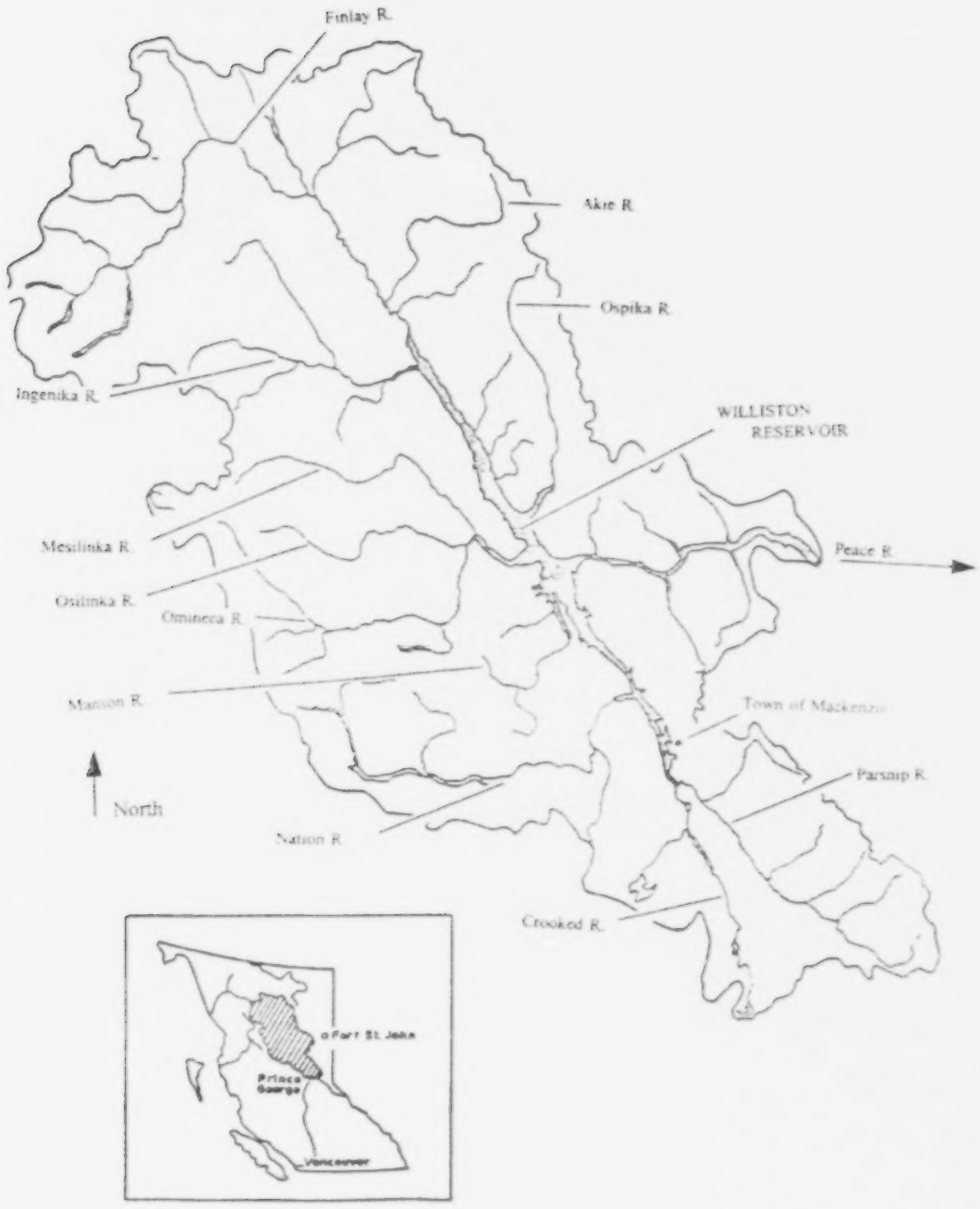


Figure 1. Williston Reservoir and surroundings.

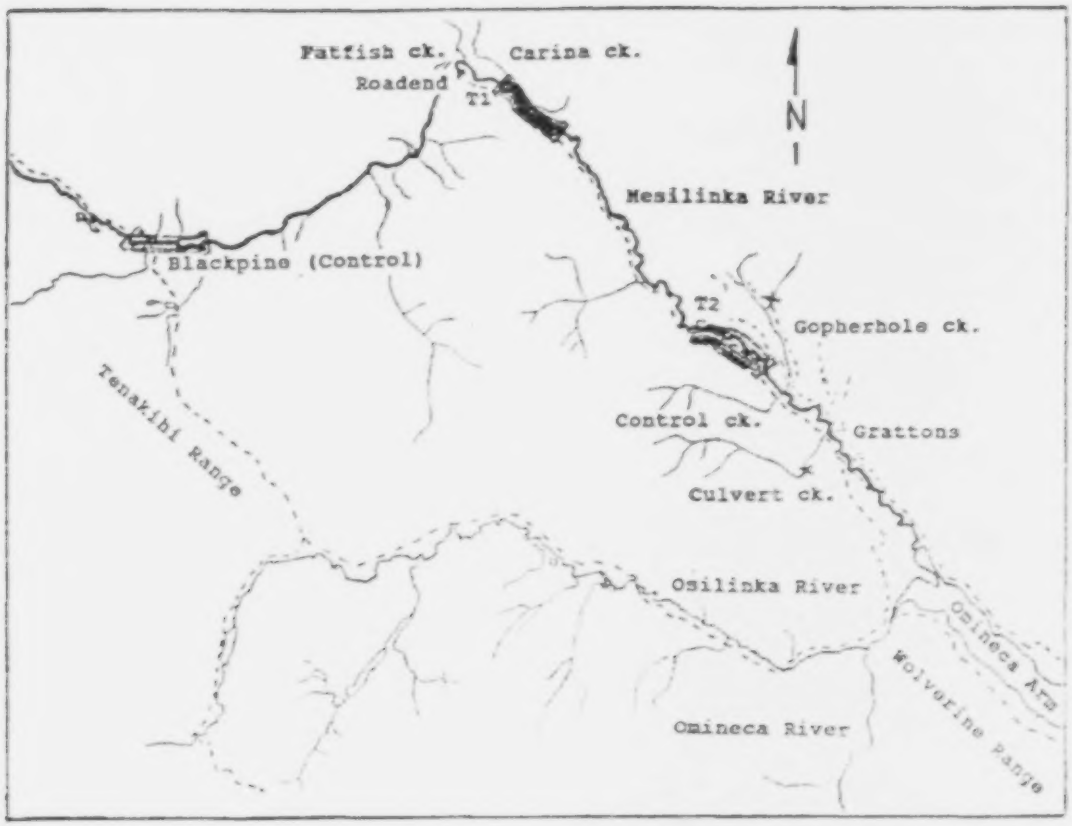


Figure 2. Mesilinka River project area.

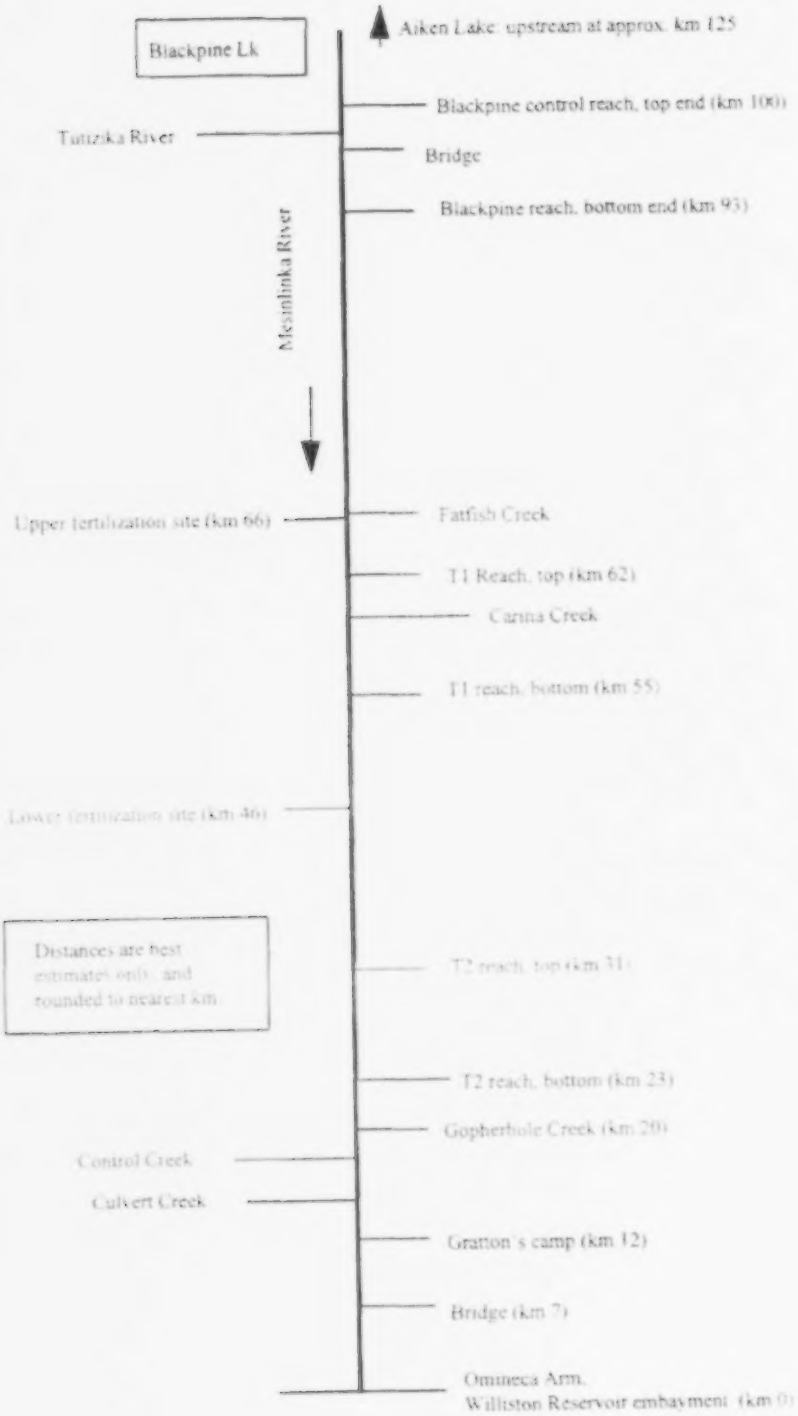

Blackpine Lk
Aiken Lake: upstream at approx. km 125
Blackpine control reach, top end (km 100)
Tutizka River
Bridge
Blackpine reach, bottom end (km 93)
Mesilinka River
Upper fertilization site (km 66)
Fatfish Creek
T1 Reach, top (km 62)
Carina Creek
T1 reach, bottom (km 55)
Lower fertilization site (km 46)
Distances are best estimates only, and rounded to nearest km
T2 reach, top (km 31)
T2 reach, bottom (km 23)
Gopherhole Creek (km 20)
Control Creek
Culvert Creek
Gratton's camp (km 12)
Bridge (km 7)
Omineca Arm,
Williston Reservoir embayment (km 0)

Figure 3. Schematic of the Mesilinka River project area.

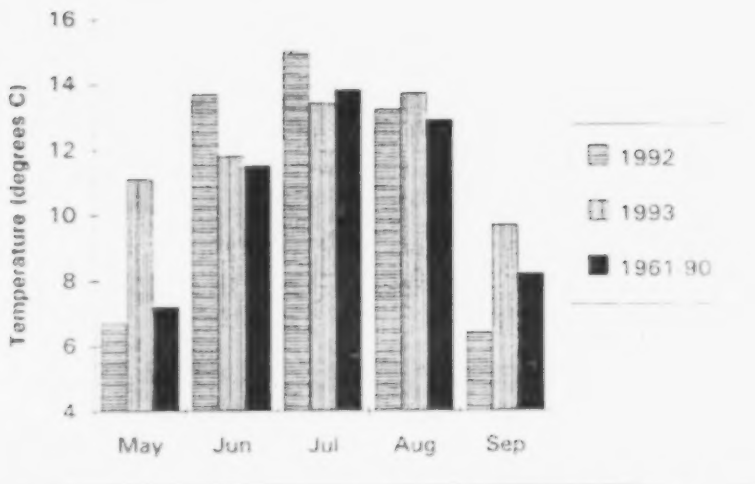


Figure 4. Mean monthly temperatures at Germansen Landing (55 km south of Mesilinka R., T2).

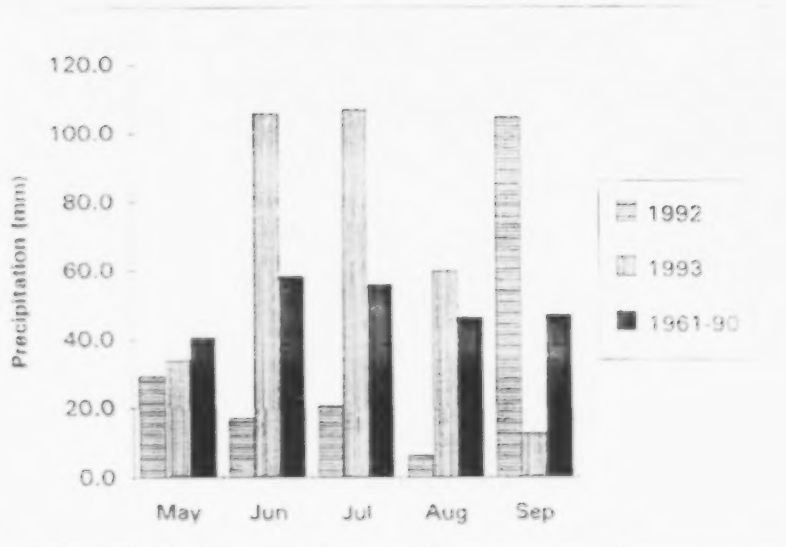
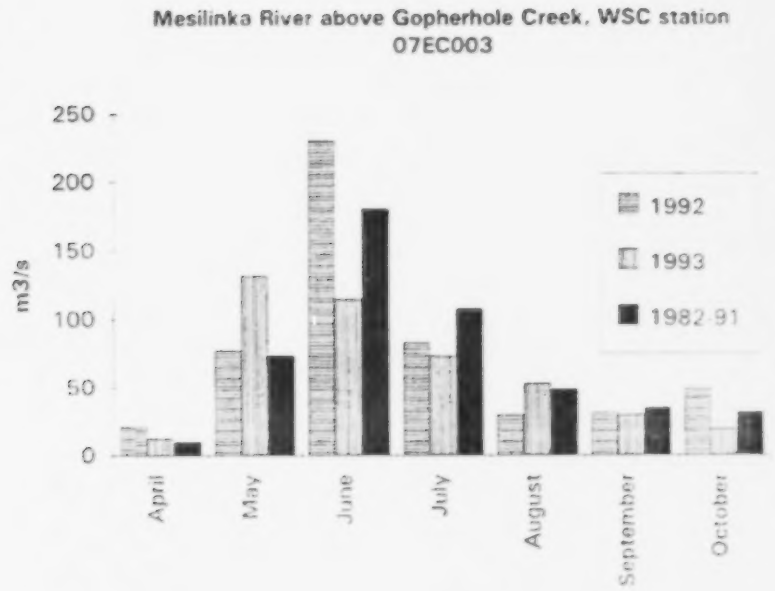


Figure 5. Precipitation record at Germansen Landing (55 km south of Mesilinka R., T2)



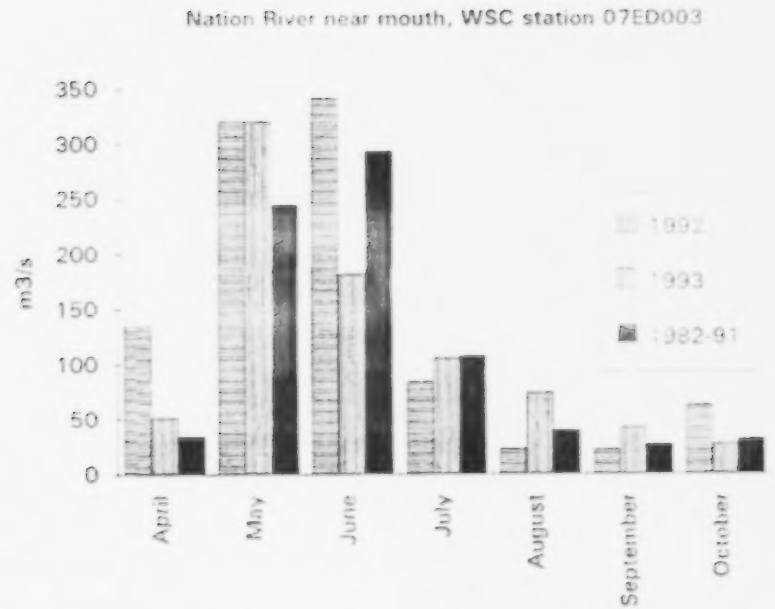


Figure 6. Mesilinka and Nation R. monthly flows, 1992-93, and 10 yr ave.

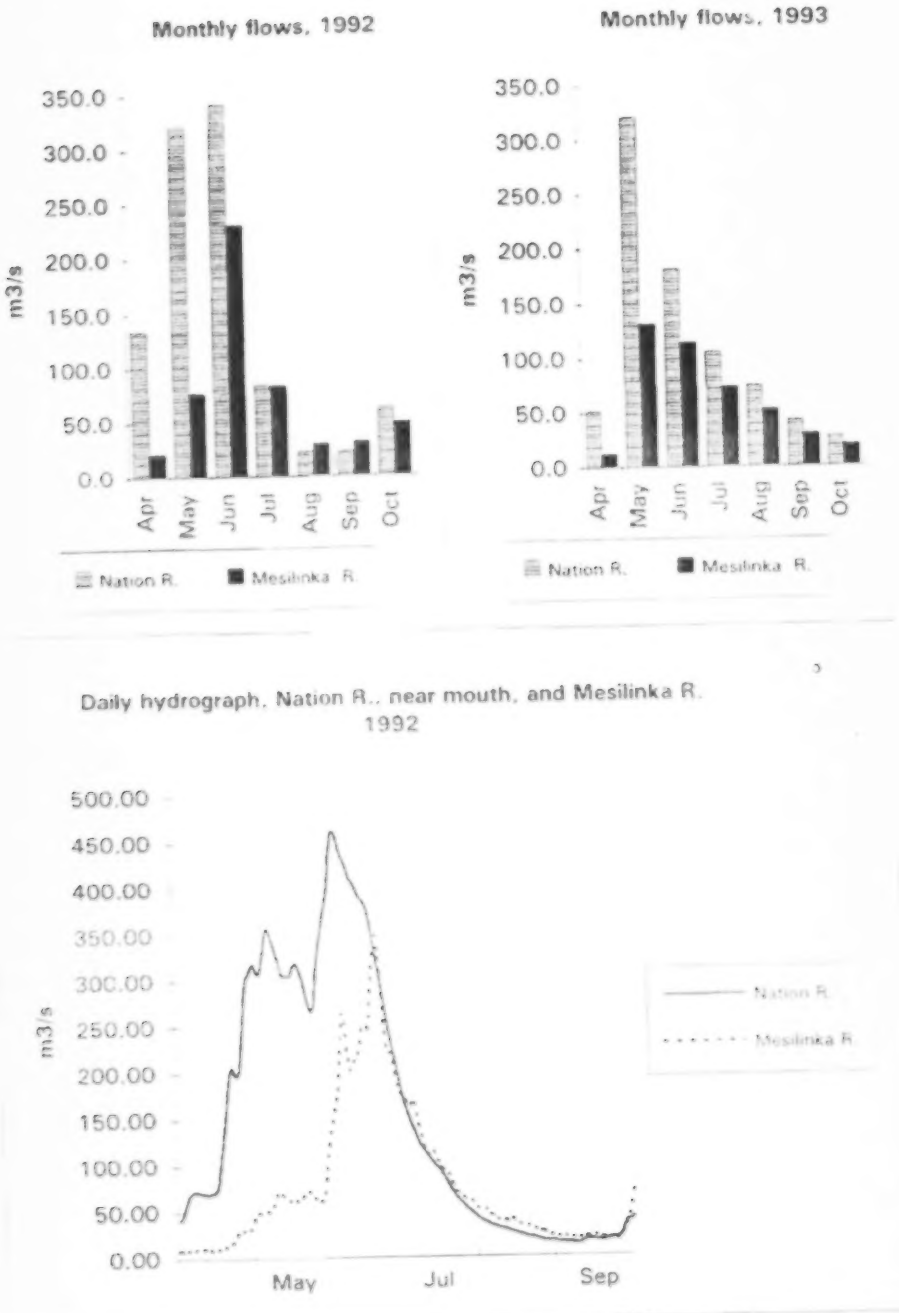


Figure 7. Comparison of mean monthly and daily flows, Nation and Mesilinka rivers.

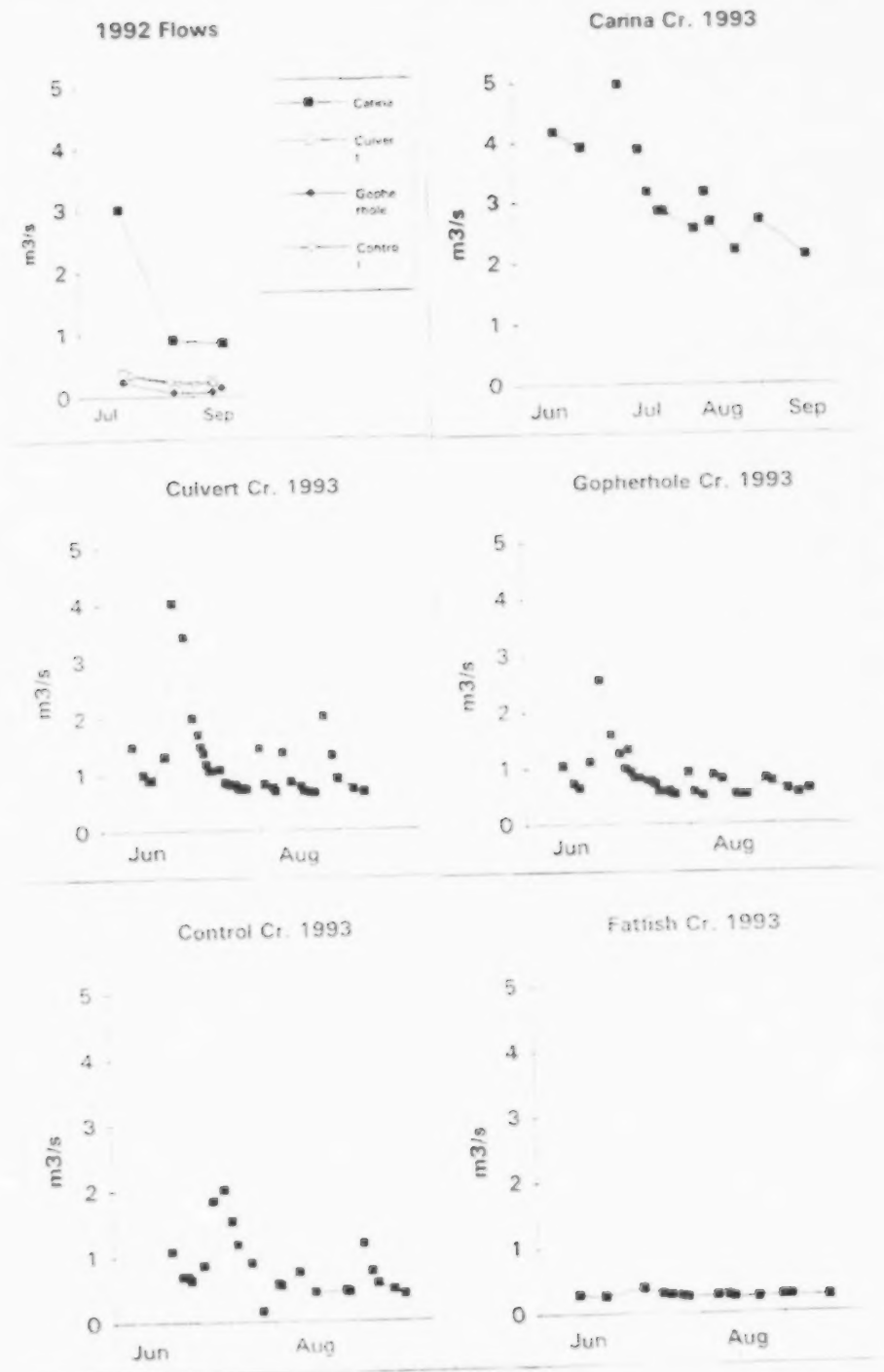


Figure 8. Mesilinka River tributary flows, 1992-93.

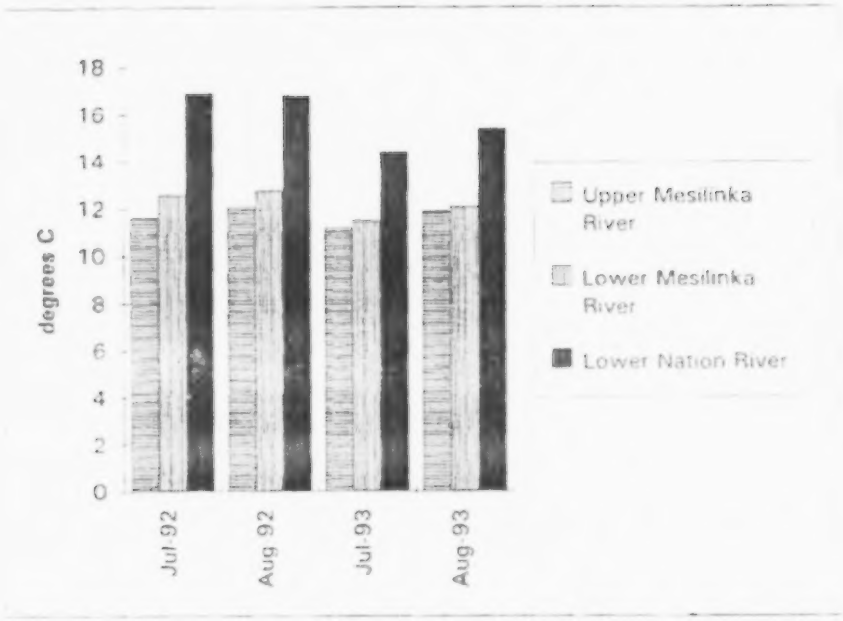


Figure 9. Mean monthly water temperatures, Mesilinka and Nation rivers, 1992-93.

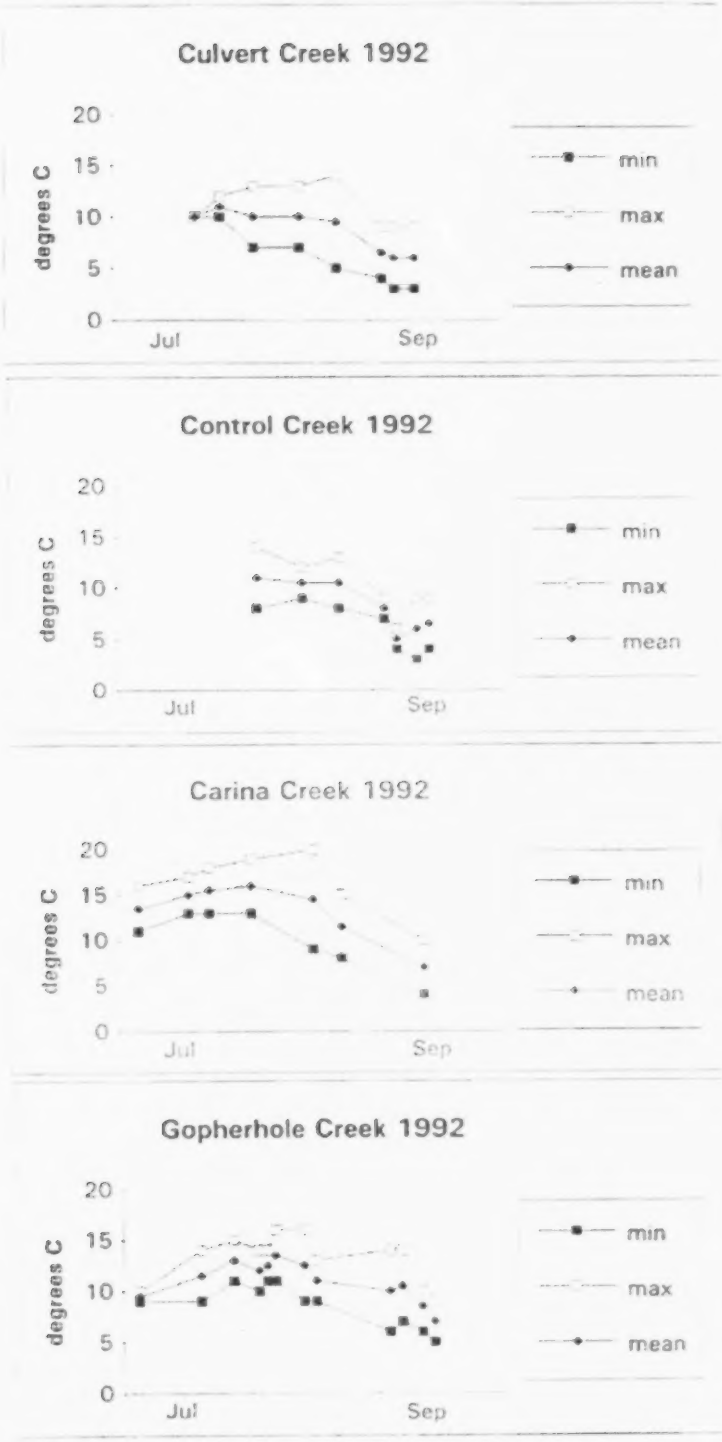
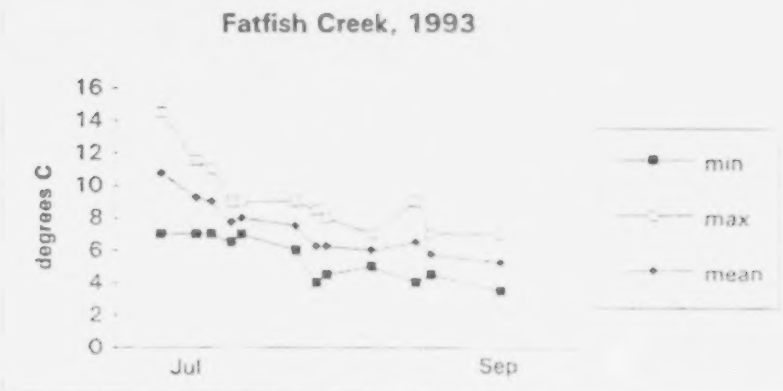


Figure 10. Water temperatures, Mesilinka tributaries, 1992.

From max-min thermometer recording:



From thermograph recordings:

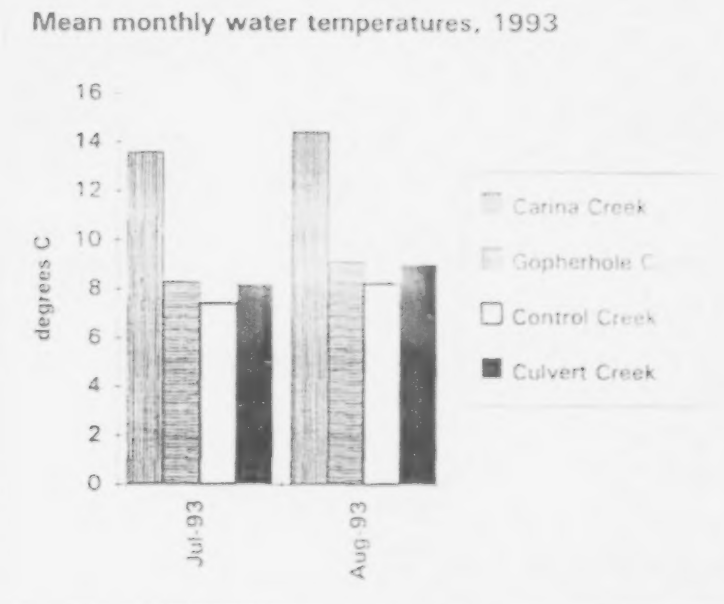


Figure 11. Water temperatures, Mesilinka tributaries, 1993.

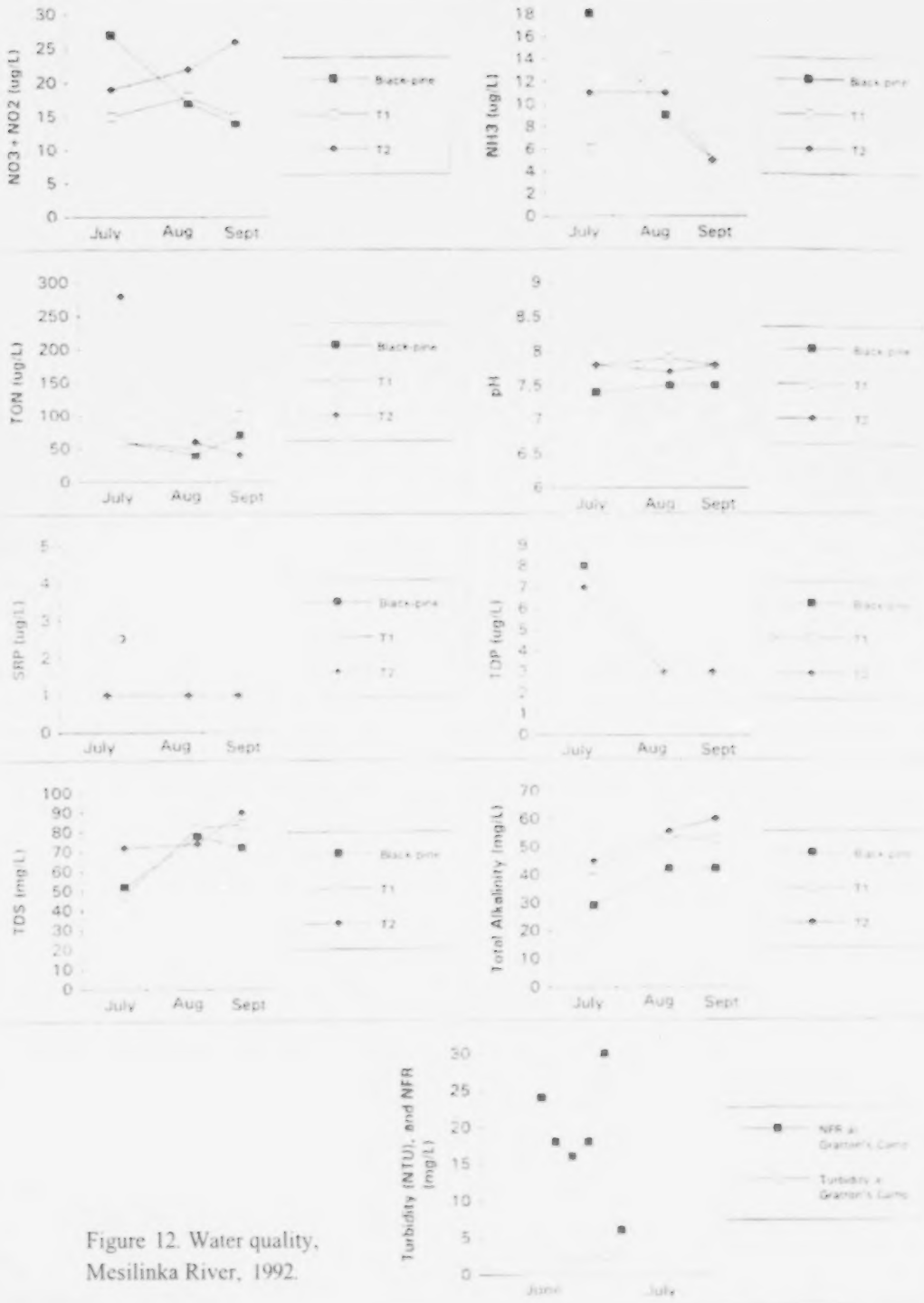


Figure 12. Water quality, Mesilinka River, 1992.

Figure 13. Water quality, Mesilinka River sites, 1993.

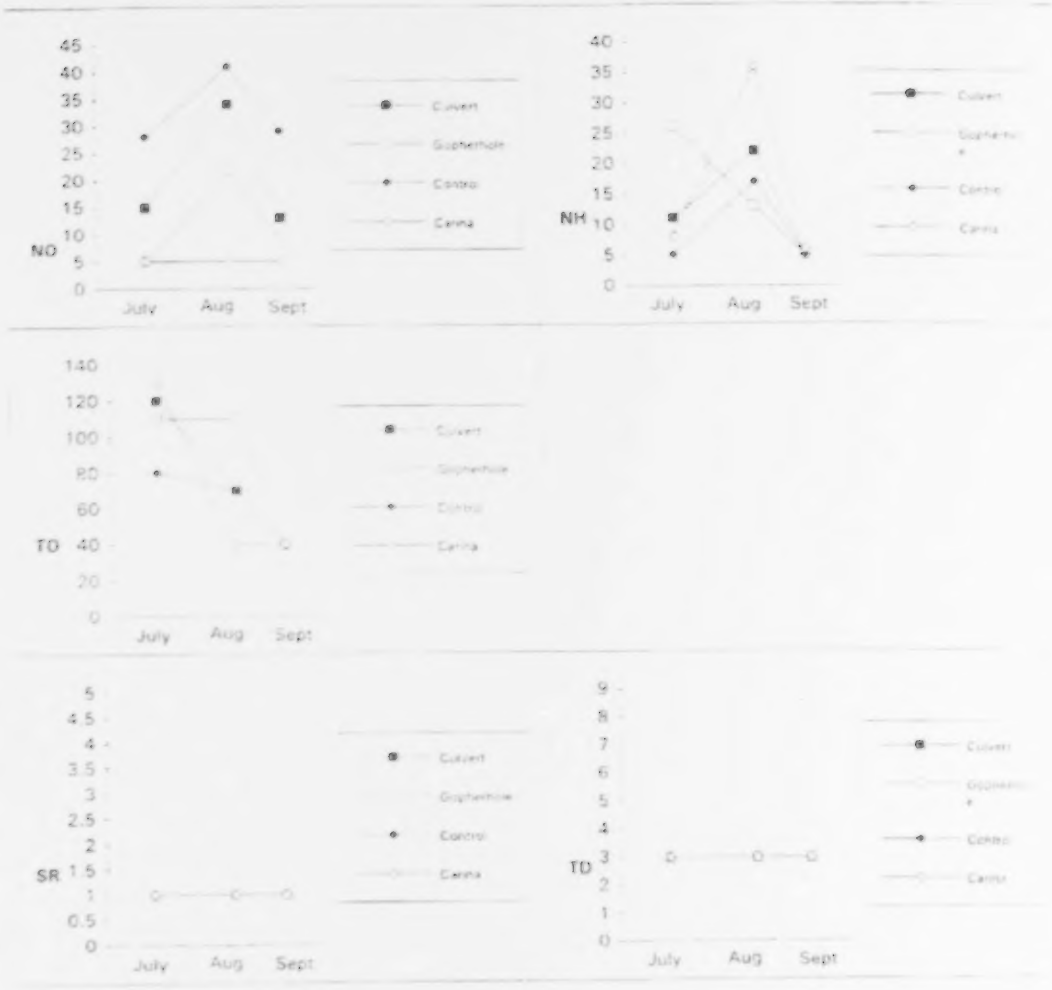


Figure 14. Water quality, Mesilinka River tributaries, 1992.

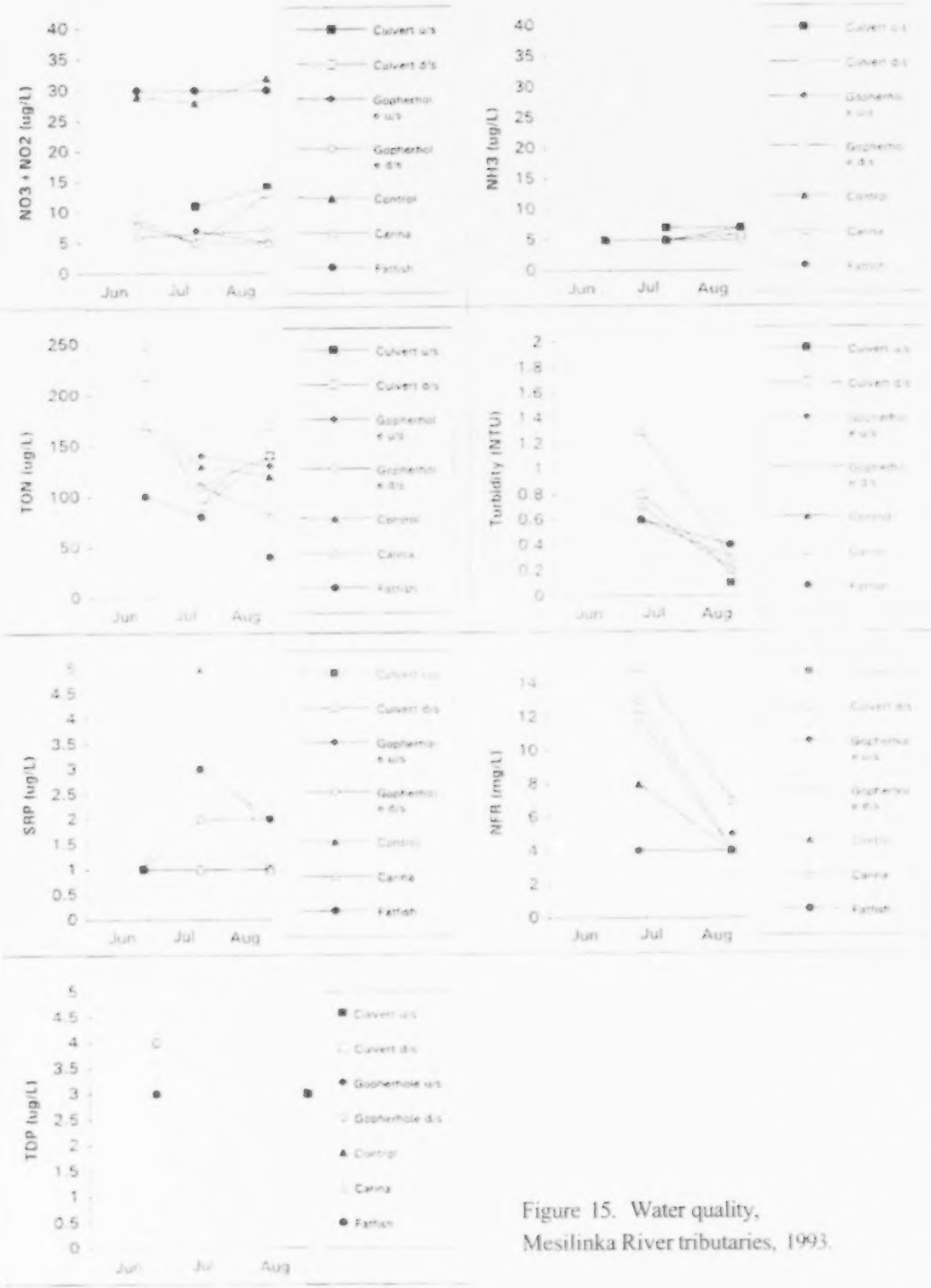


Figure 15. Water quality, Mesilinka River tributaries, 1993.

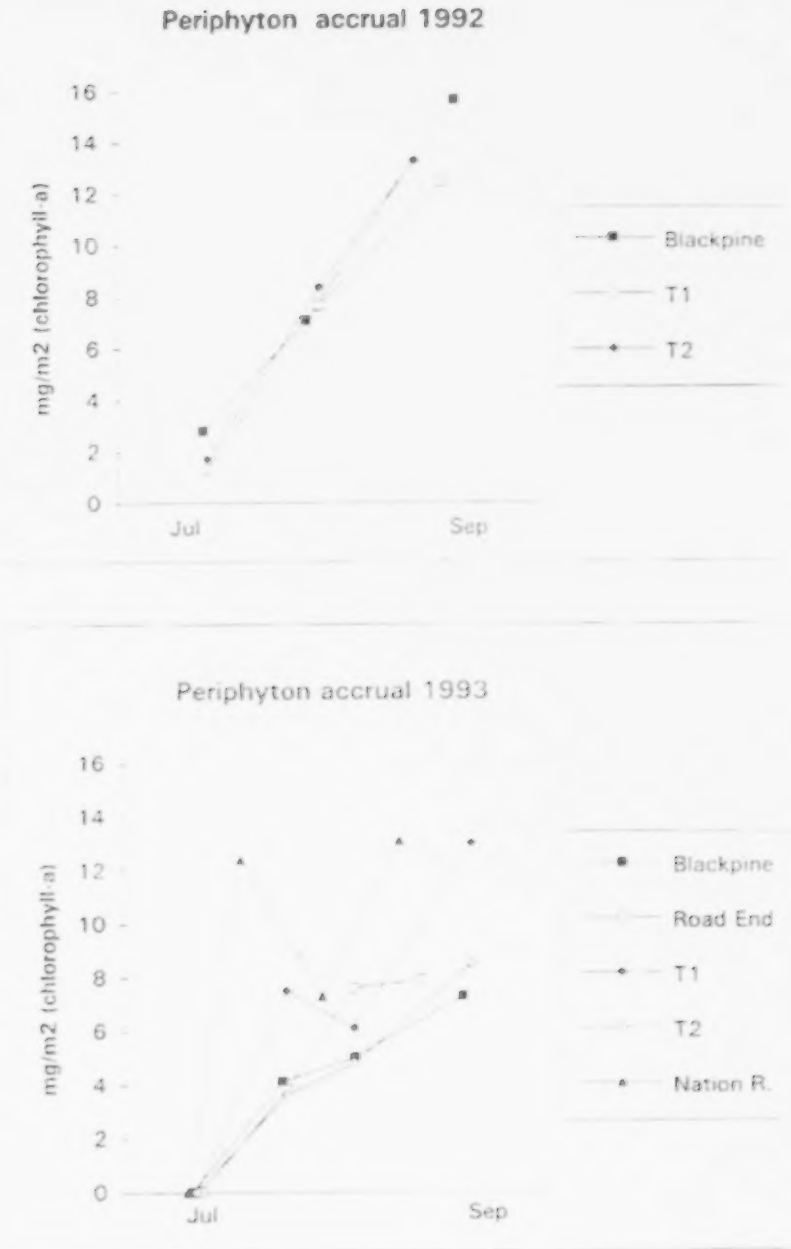
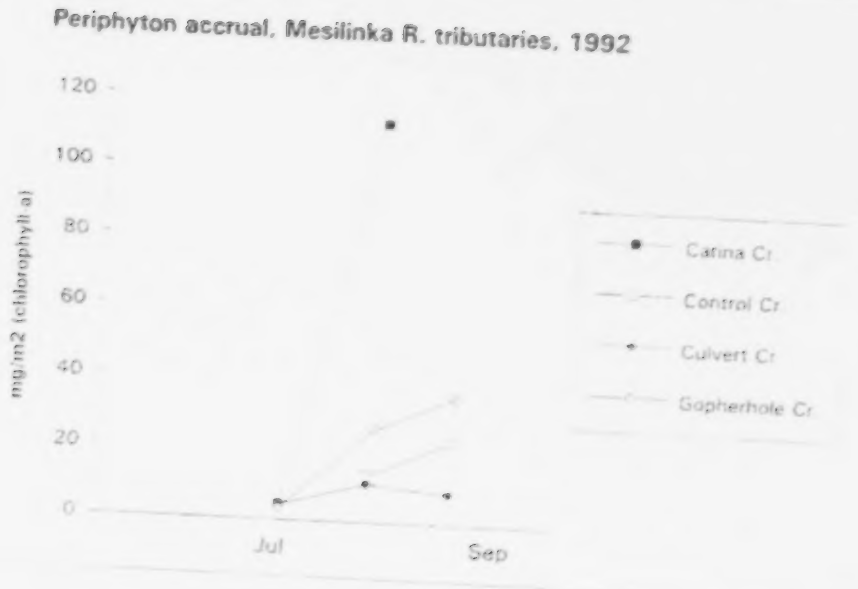


Figure 16. Periphyton accrual on artificial substrate, Mesilinka R. sites 1992-93; Nation R. 1993.



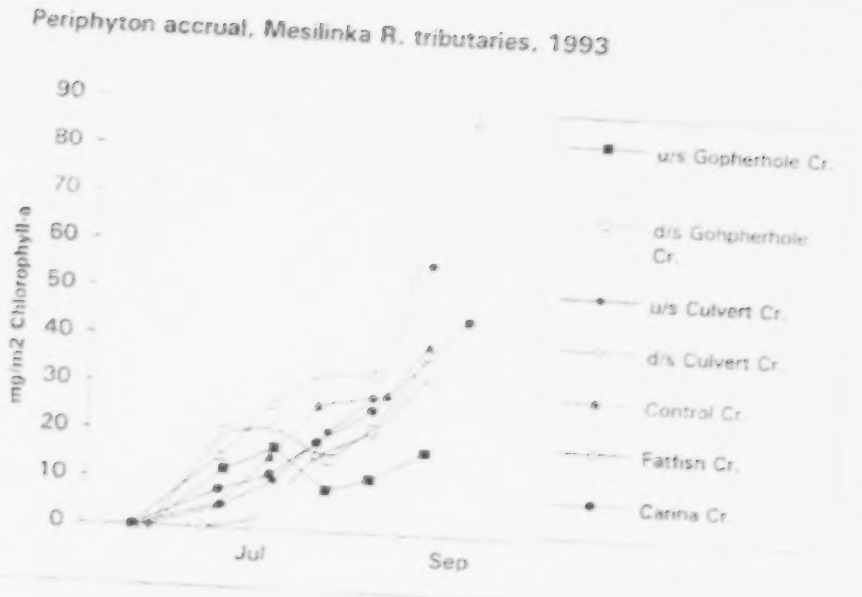


Figure 17. Periphyton accrual on artificial substrate, Mesilinka River tributaries, 1992-93.

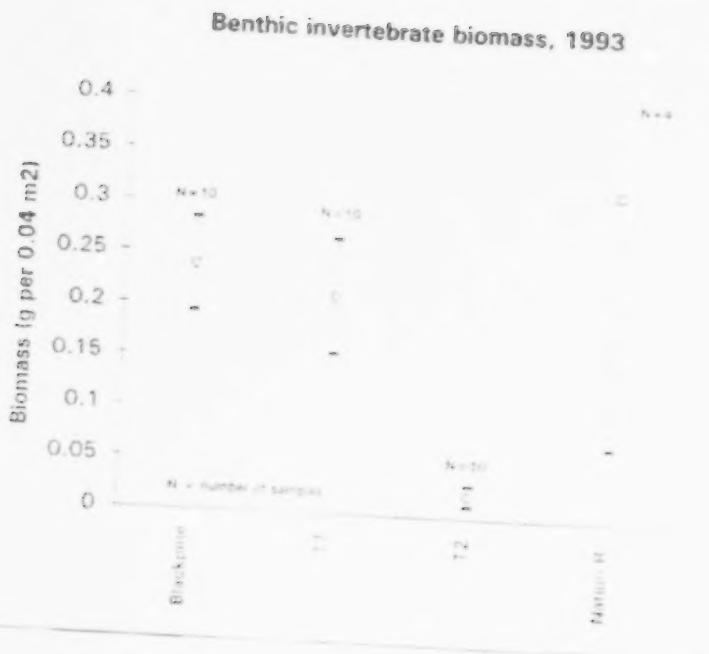


Figure 18. Biomass of benthic invertebrates, Mesilinka and Nation rivers, 1993, average +/- 1 SE.

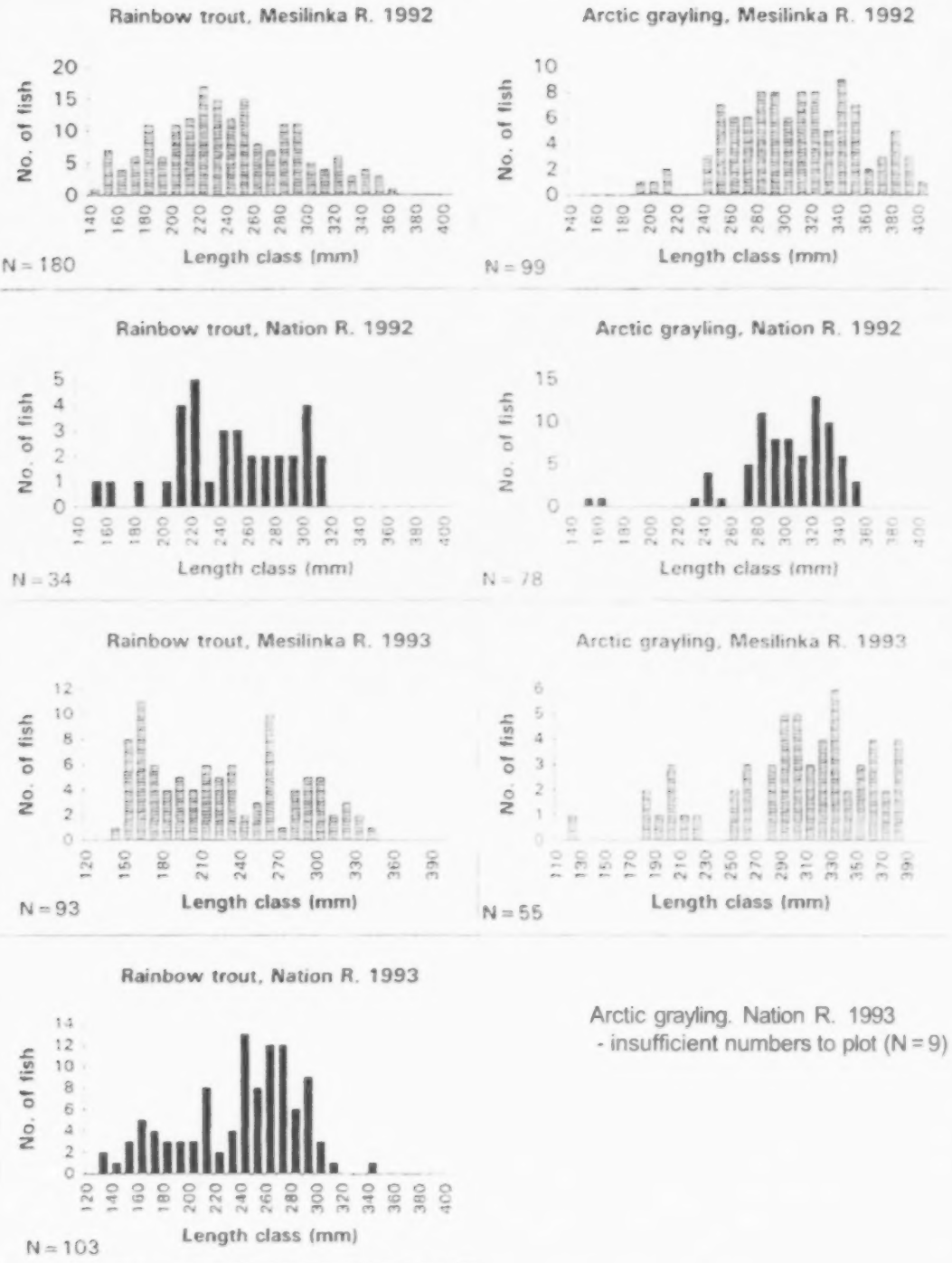
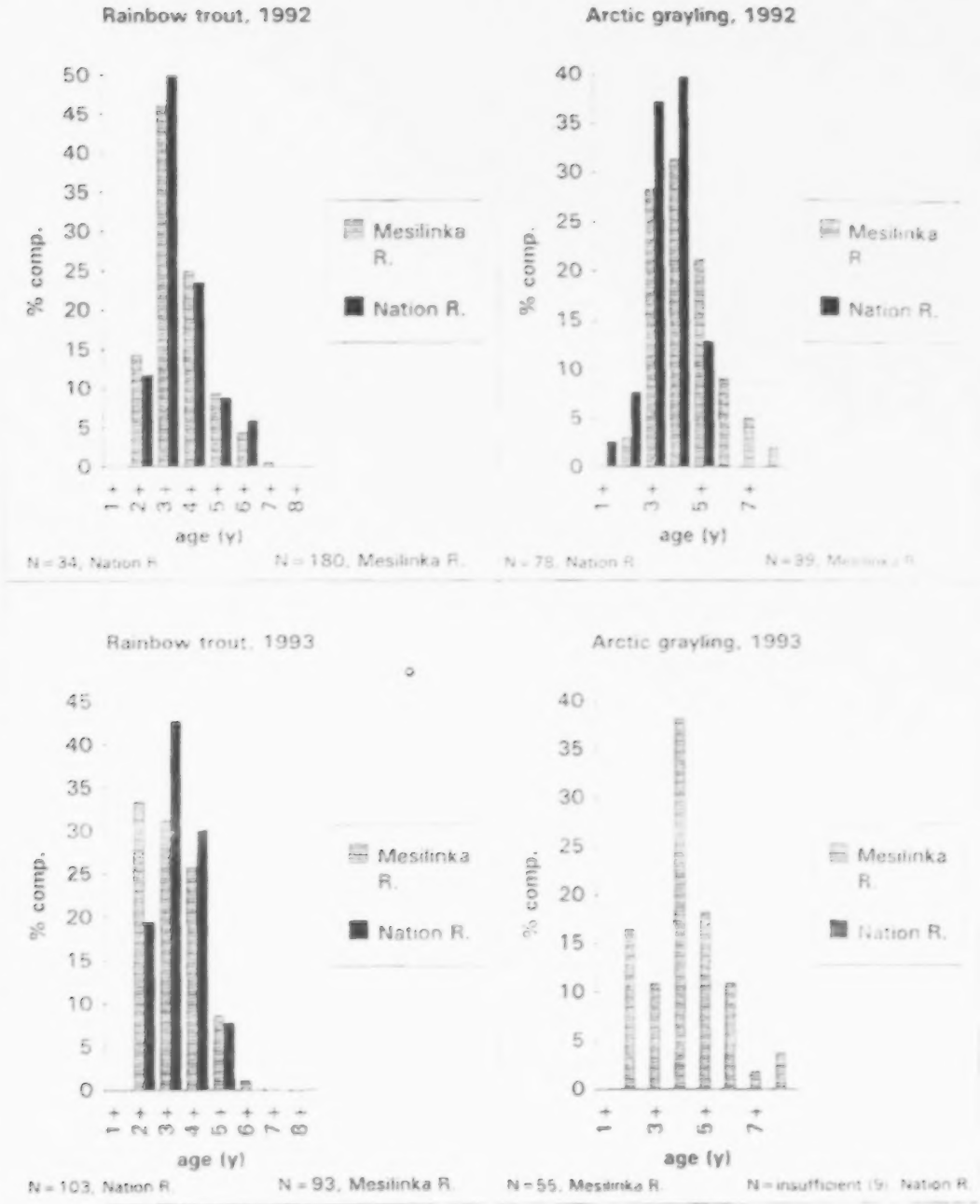
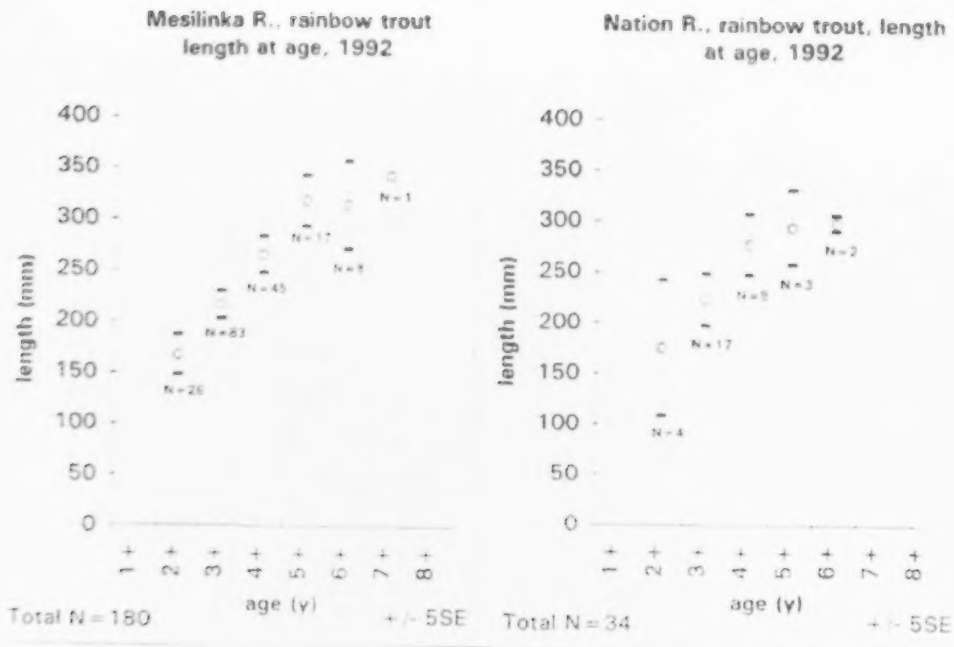


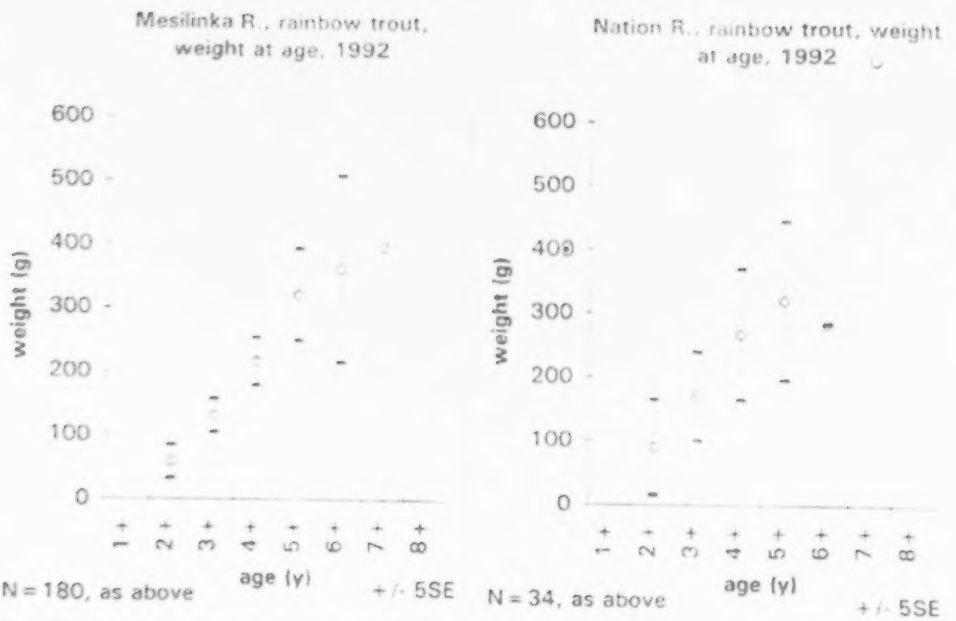
Figure 19. Length-frequency distributions, Mesilinka and Nation rivers, 1992-93.



- Insufficient grayling (nine only) were caught in the Nation River during the 1993 angling activity, and therefore the data are not plotted.

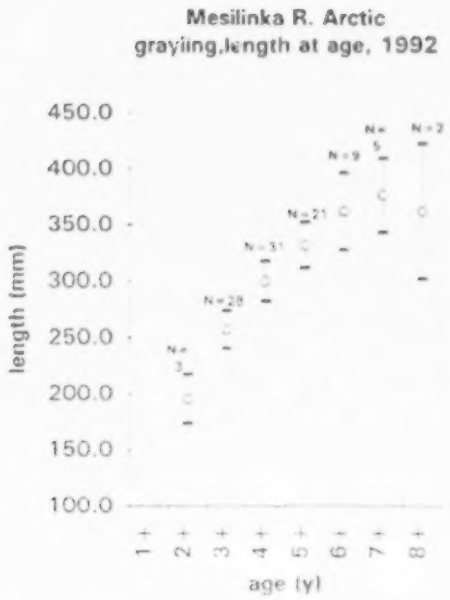
Figure 20. Percent composition of angled rainbow trout and Arctic grayling 1992-93.

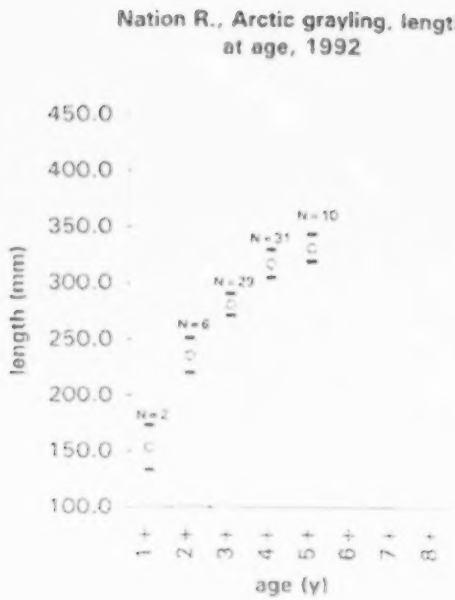


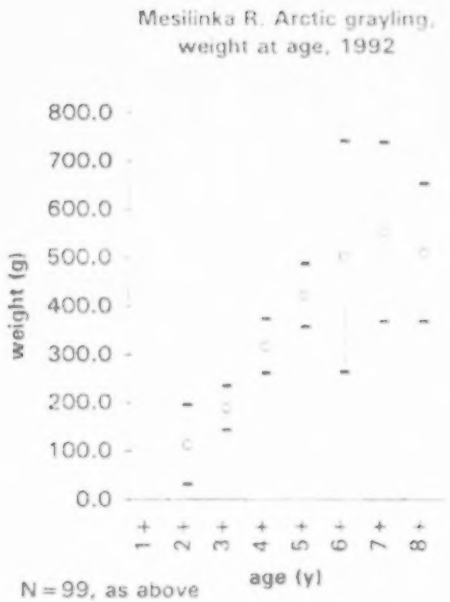


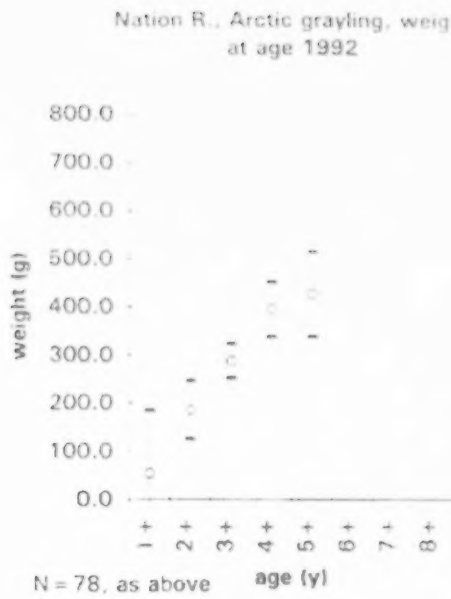
SE = standard error of the mean; N = number of fish

Figure 21. Rainbow trout, length and weight at ages, Mesilinka and Nation rivers, 1992, (average +/- 5SE).



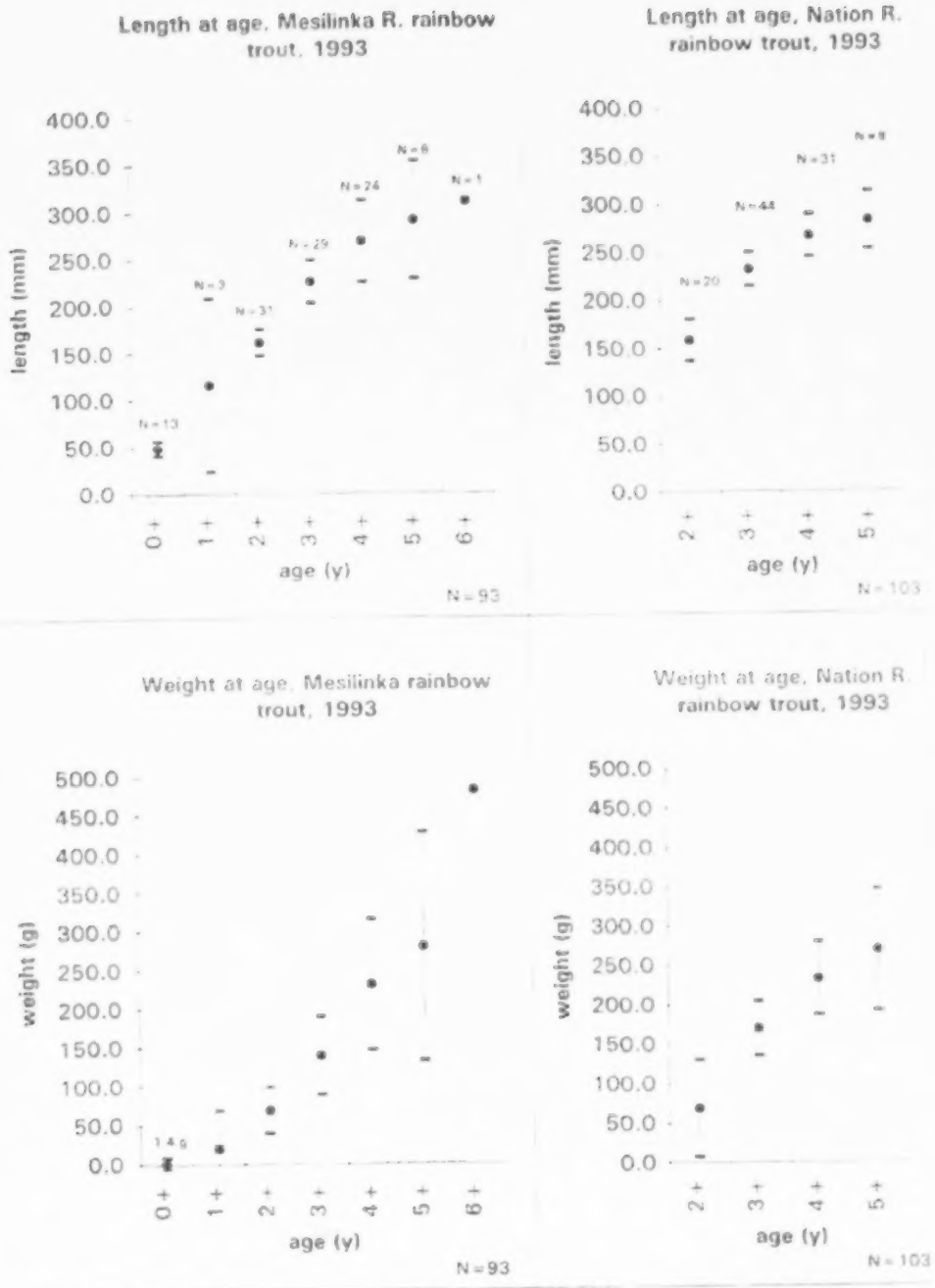






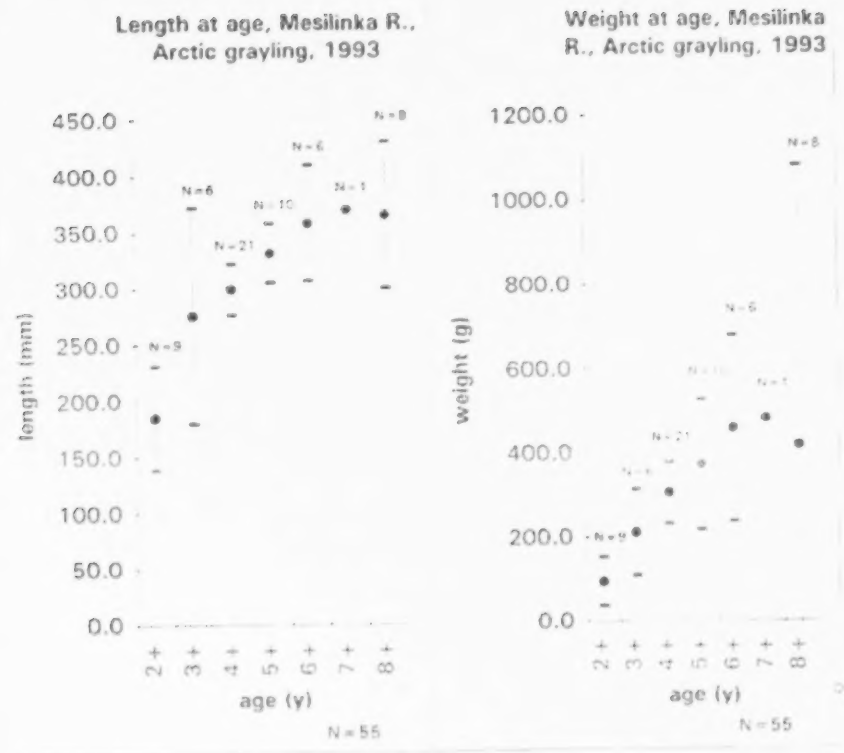
SE = standard error of the mean; N = number of fish.

Figure 22. Arctic grayling length and weight at ages, Mesilinka and Nation rivers, 1992, (average +/- 5SE).



SE = standard error of the mean; N = number of fish.

Figure 23. Rainbow trout, length and weight at ages, Mesilinka and Nation rivers,1993, (ave. +/- 5SE).



SE, standard error of the mean; N, number of fish.

Figure 24. Arctic grayling, length and weight at age, Mesilinka R., 1993, (average +/- 5SE).

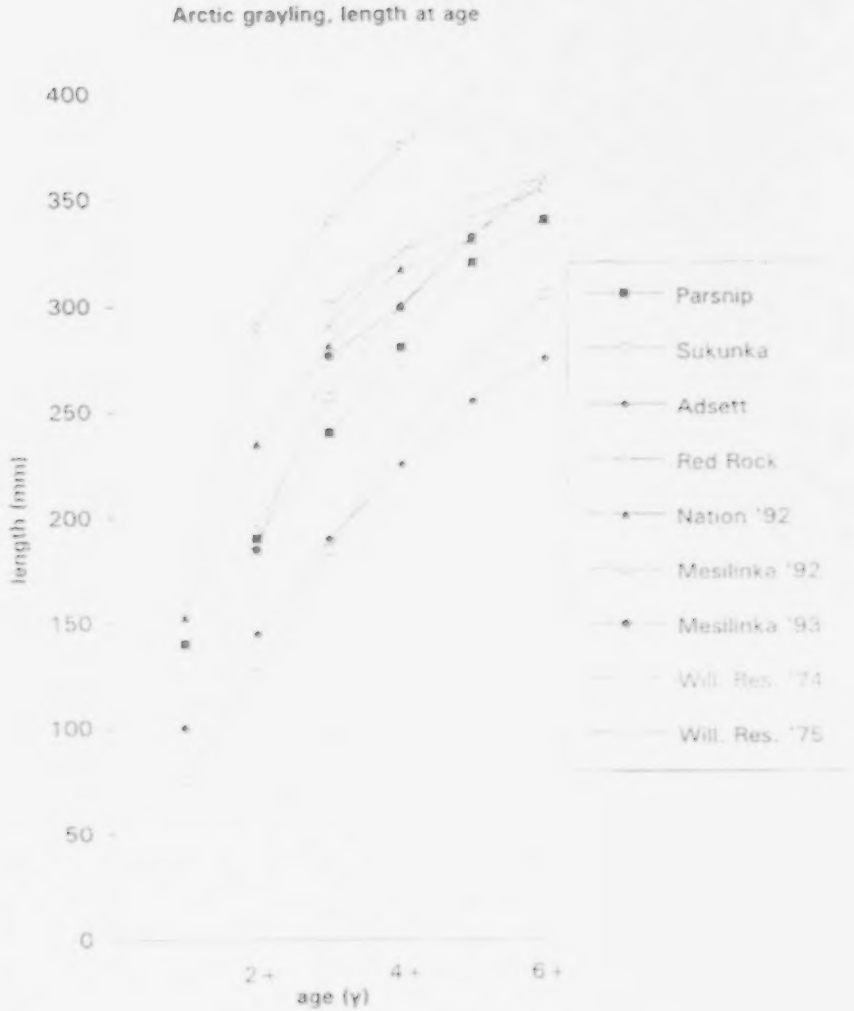


Figure 25. Length-at-age, Arctic grayling at various locations (fork length, mm).

- The Parsnip R. drainage is part of the southern Peace system; data from Anonymous (1978).
- The Sukunka R. drainage is part of the northern Peace system; data from Stuart and Chislett (1979)
- Adsett Creek is part of the Liard system in northern B.C.; data from Stewart et al. (1982).
- Red Rock Lake is located in Montana; data from Nelson (1954).
- Original references, above, not seen; cited in Northcote (1993).
- Williston Reservoir (Will. Res.) 1974, 1975 data, from Barrett and Halsey (1985).
- Time of year sampled will affect variation in lengths, especially in age 0+ to 3+.
- River and lake fish growth dynamics are not similar;

Red Rock L. and Williston Res. plotted for comparison only.

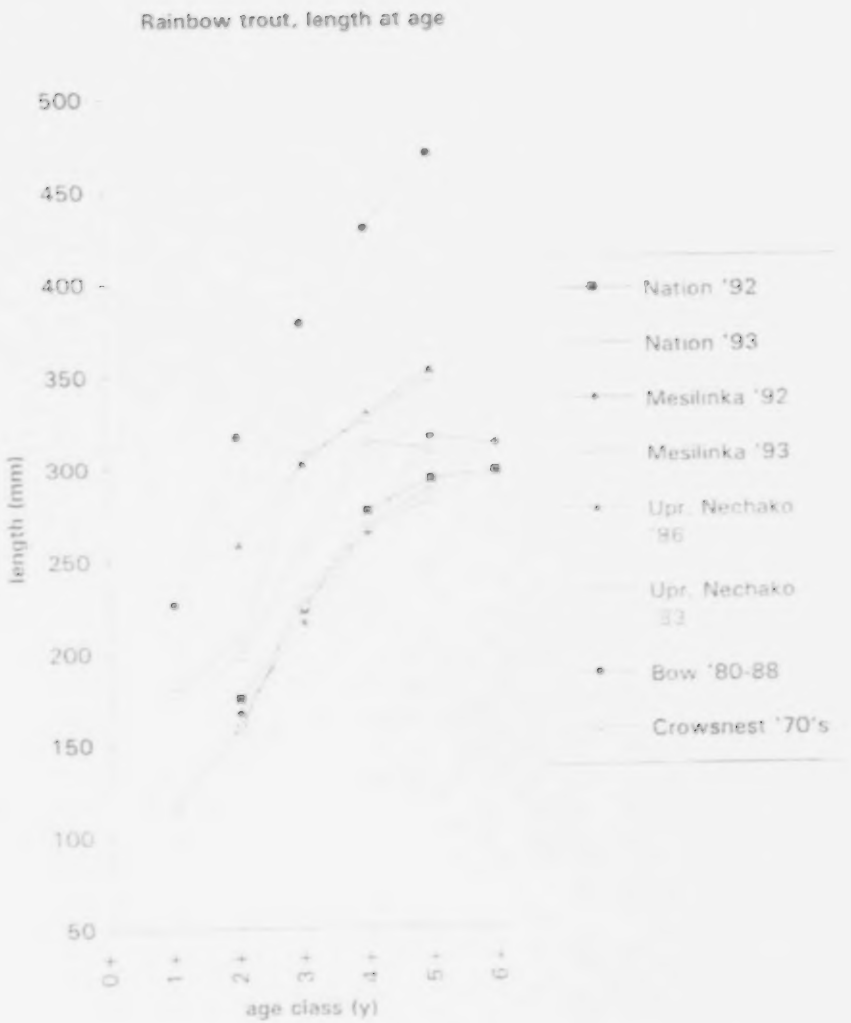


Figure 26. Length-at-age, rainbow trout at various locations (fork length, mm).

- Upper Nechako River, Reach One, 1983 and 1986, pre- and post sportfishery closure, respectively (Slaney 1986).
- Nation River, below Chuchi Lake; and Mesilinka River, average of Blackstone, T1 and T2 reaches.
- Bow River, downstream of the City of Calgary, AB, 1980-85 and 1988, in Courtney and Fernet (1990).
- Crowsnest R. (AB), from below Lundbreck Falls, 1977 (age 1-4), below towns of Frank and Bellevue, average of 2 fish only, for age 5.
- Crowsnest R. data from Fish and Wildlife Branch files, Alberta Environmental Protection, Lethbridge AB.
- time of year sampled will affect variation in lengths, especially in age 0+ to 3.

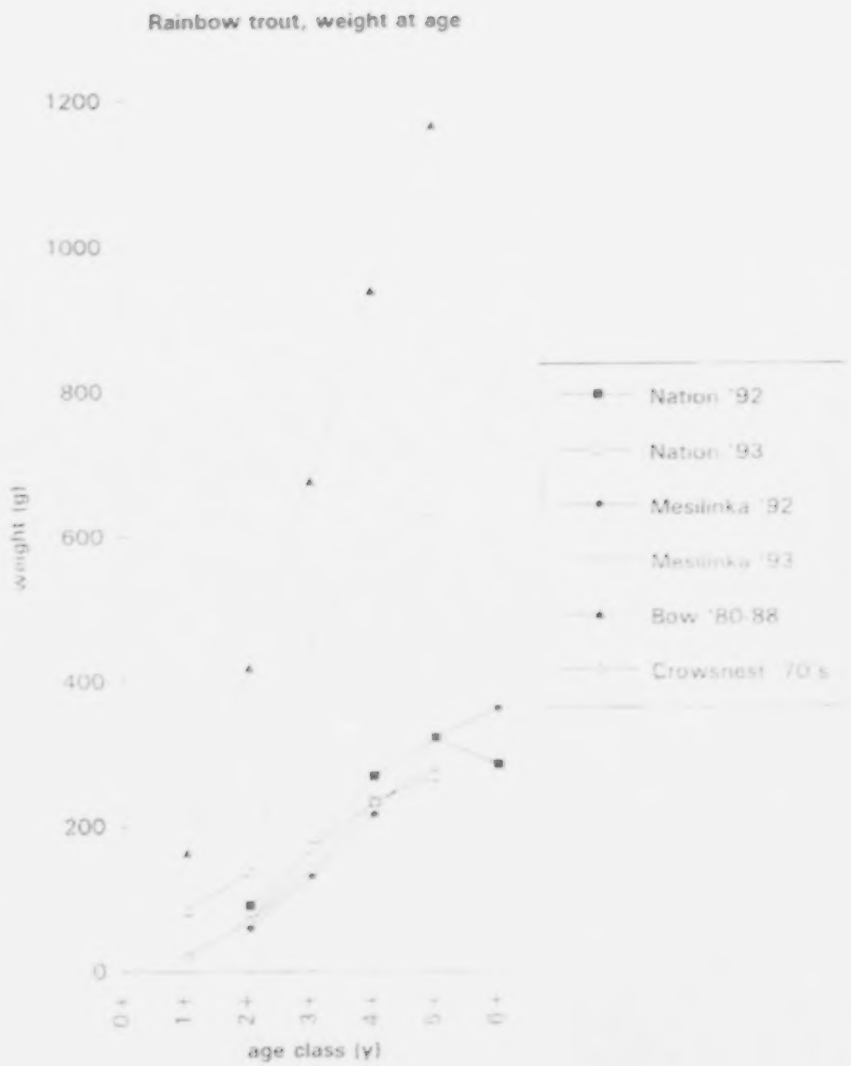


Figure 27. Weight-at-age, rainbow trout at various locations.

- Nation River, below Chuchi Lake; and Mesilinka River, average of Blackpine, T1 and T2 reaches.
- Bow River, downstream of the City of Calgary, AB. 1980-85 and 1988; in Courtney and Ferriet (1988).
- Crowsnest R. (AB), from below Lundbreck Falls, 1977 (age 1-4); below towns of Frank and Bellevue; average of 2 fish only, for age 5.
- Crowsnest R. data from Fish and Wildlife Branch files, Alberta Environmental Protection, Lethbridge, AB.
- time of year sampled will affect variation in weights, especially in age 0+ to 3+.

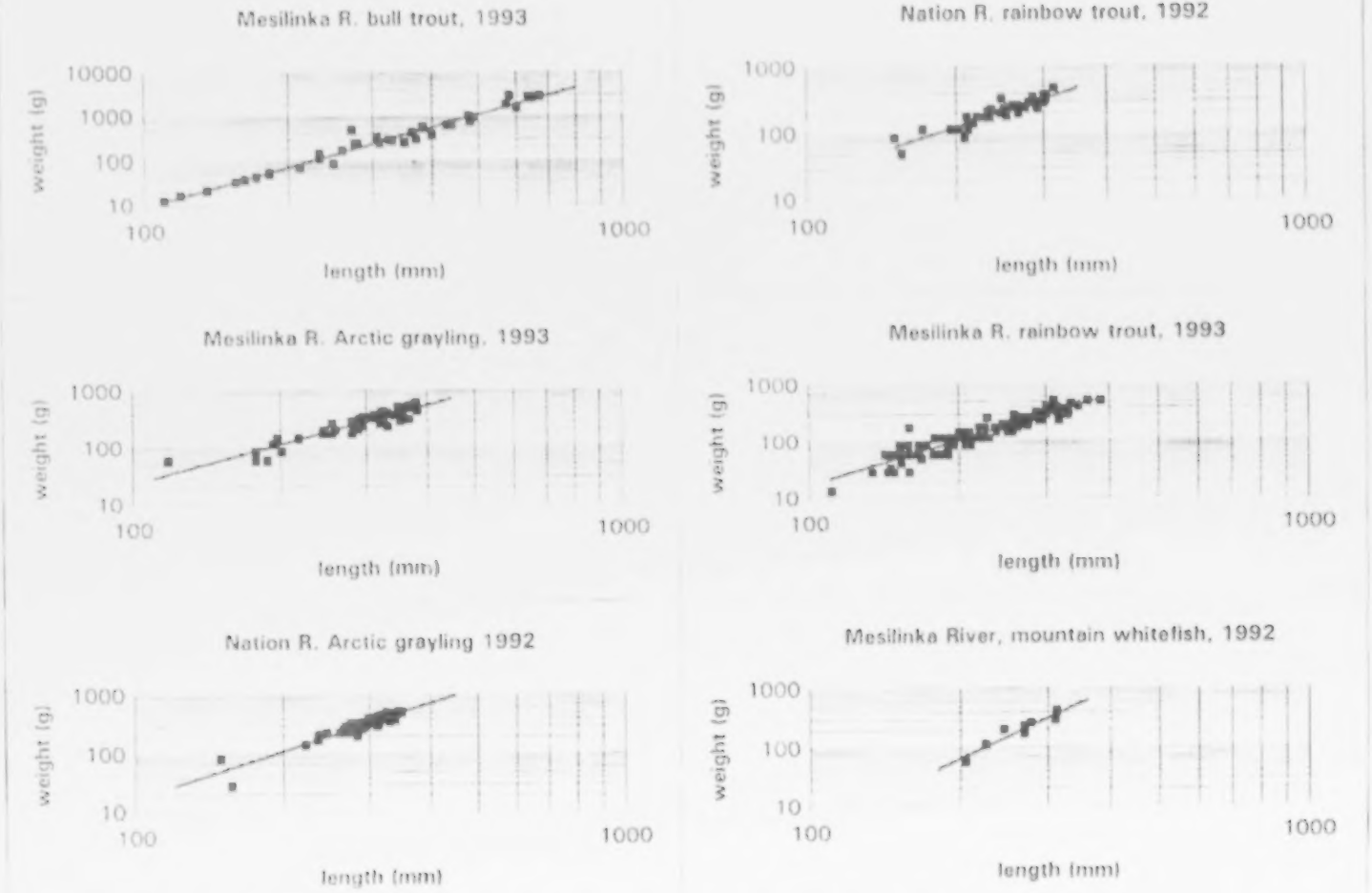


Figure 28. Select length-weight regression graphs, Mesilinka and Nation river fishes, 1992-93.

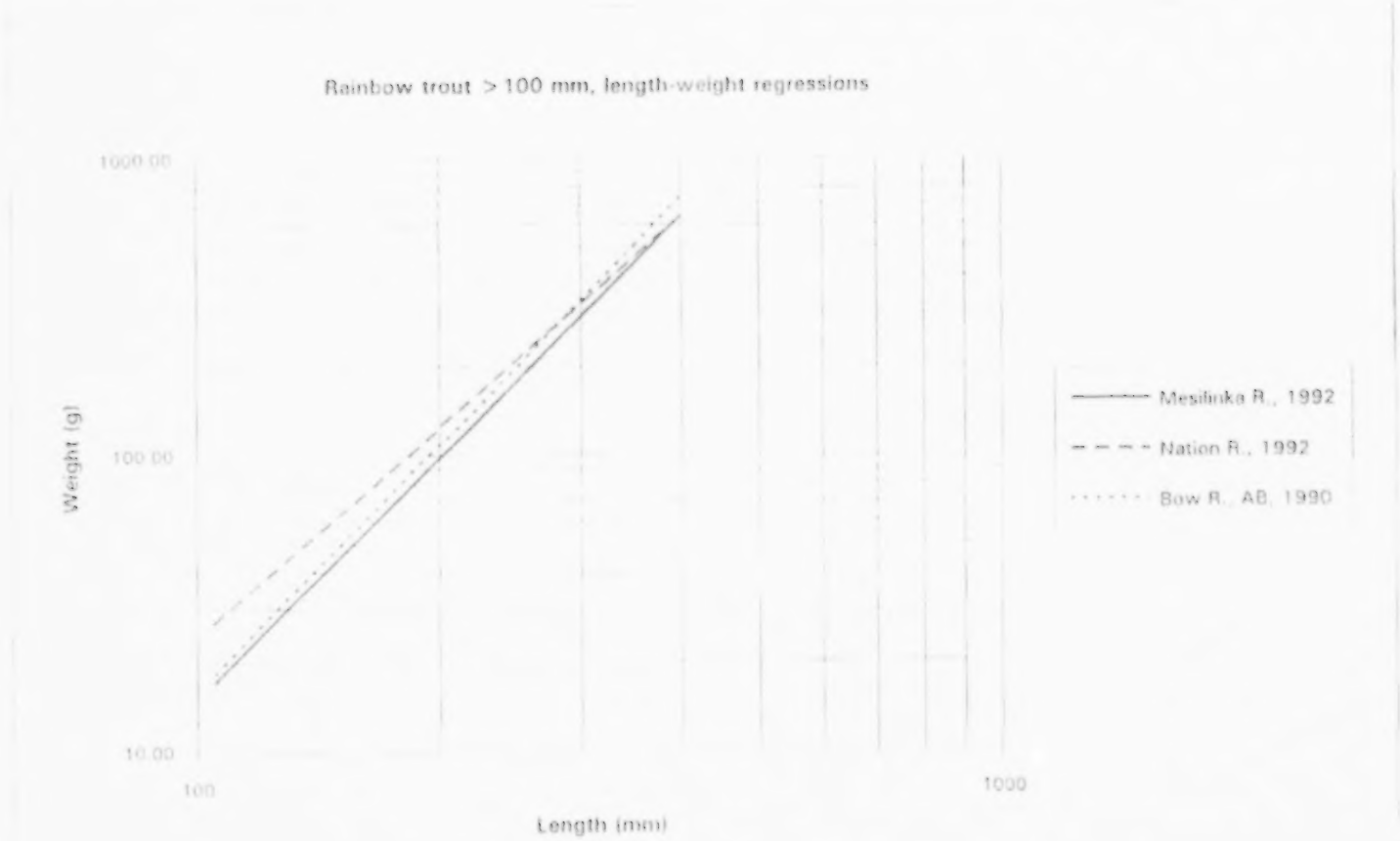


Figure 29. Comparison of rainbow trout length-weight regression lines for three rivers.

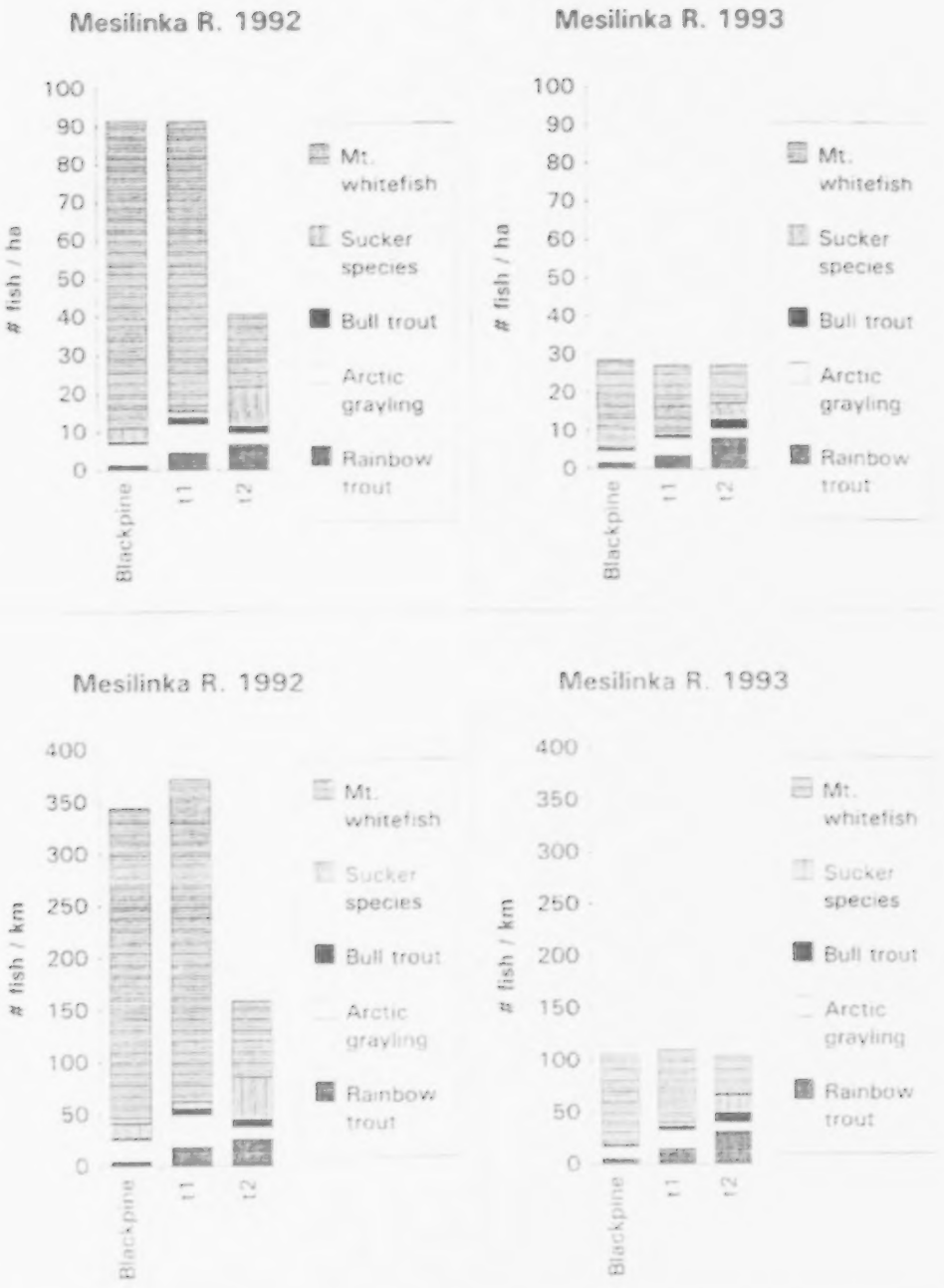


Figure 30. Number of fish per ha or km (equal and > 20 cm), Mesilinka River, 1992-93.
- based on expanded swim counts with correction factors, derived from mark-recapture results, applied.
- limited to fish equal and more than 20 cm in length since these are considered to be of angling size.

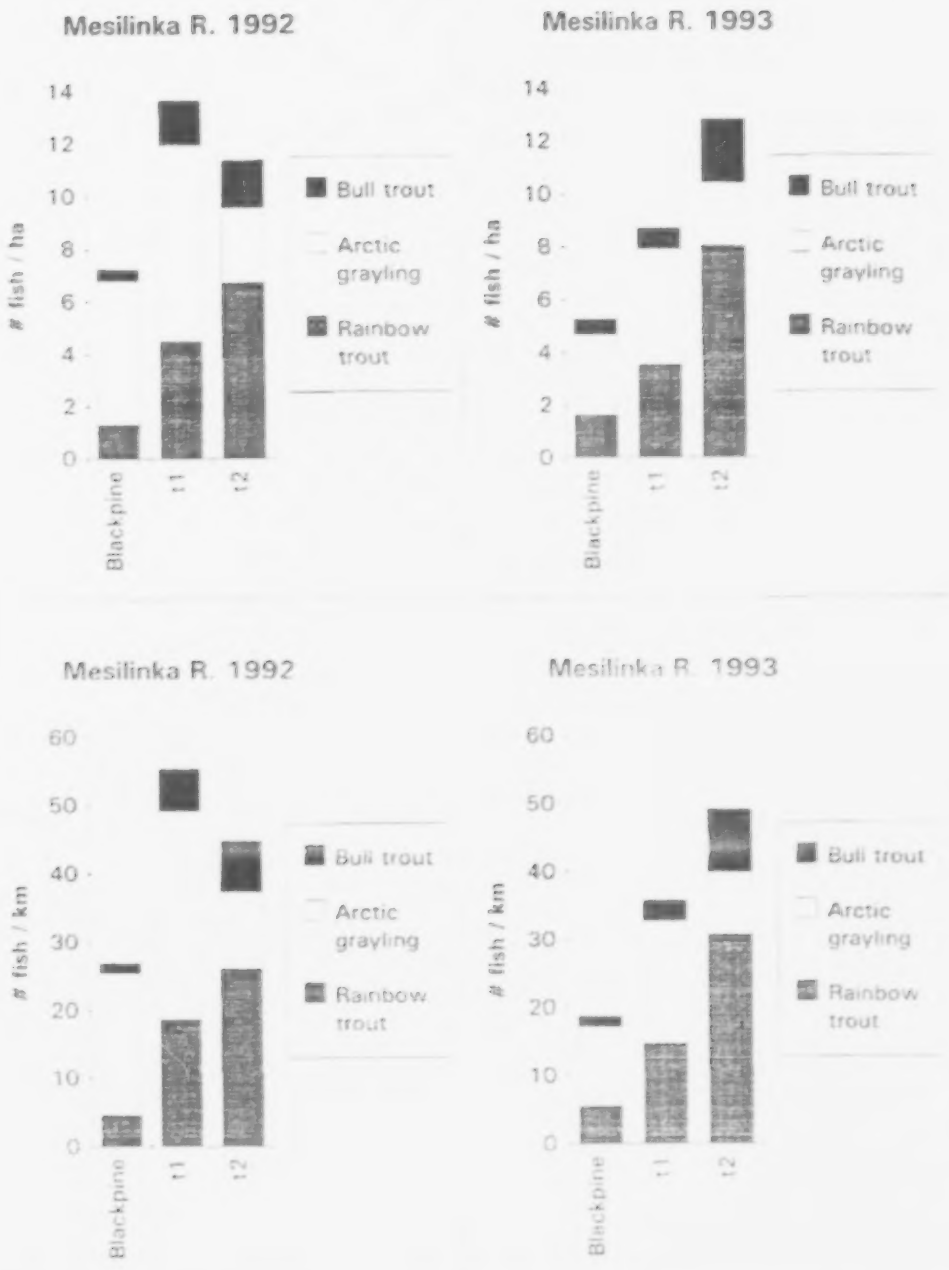
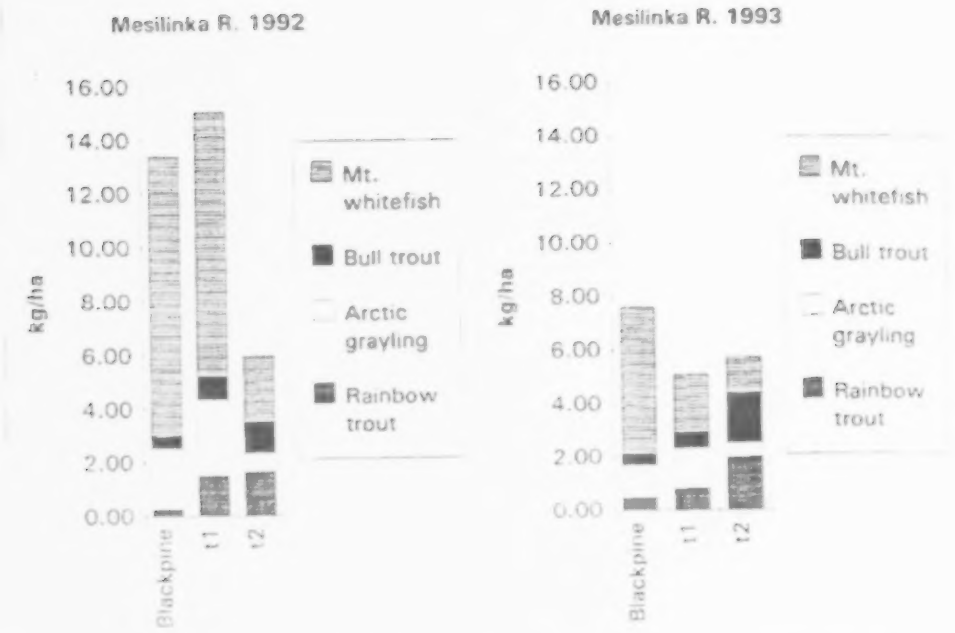


Figure 31. Rainbow trout, bull trout and Arctic grayling / ha or km, Mesilinka R., 1992-93.
- based on expanded swim counts with correction factors, derived from mark-recapture results, applied.
- limited to fish equal and more than 20 cm in length since these are considered to be of angling size.



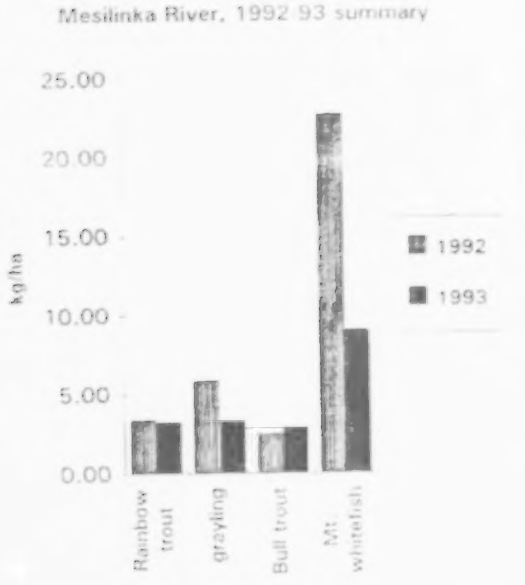


Figure 32. Standing crop (kg/ha) of salmonids (equal and > 20 cm), Mesilinka River, 1992-93.

- based on expanded swim counts with correction factors (derived from mark-recapture results) applied.
- limited to fish equal and more than 20 cm in length since these are considered to be of angling size.

Figure 33. Mesilinka flows during the underwater fish census, 1992-93

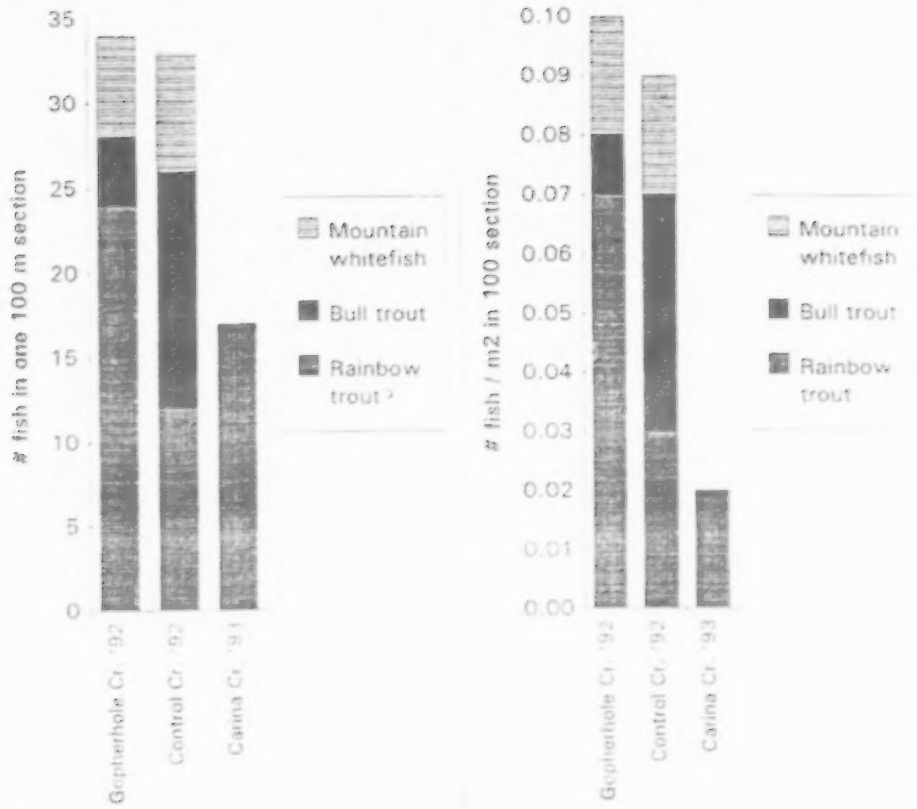


Figure 34. Fish densities (per 100 m, and per m2), Mesilinka R. tributaries, 1992-93, based on valid mark-recapture results.

- results based on only one 100 m section electrofished in each stream.
- average widths at time of sampling: Gopherhole Cr. 3.4 m; Control Cr. 3.6 m; and Carina Cr. 9 m.
- bull trout in Gopherhole Cr. included two fish > 20 cm in length.
- Mountain whitefish in Gopherhole Cr. are > 20 cm in length.
- all other fish sampled (captured by electrofishing) were less than 20 cm in length and most were less than 10 cm.

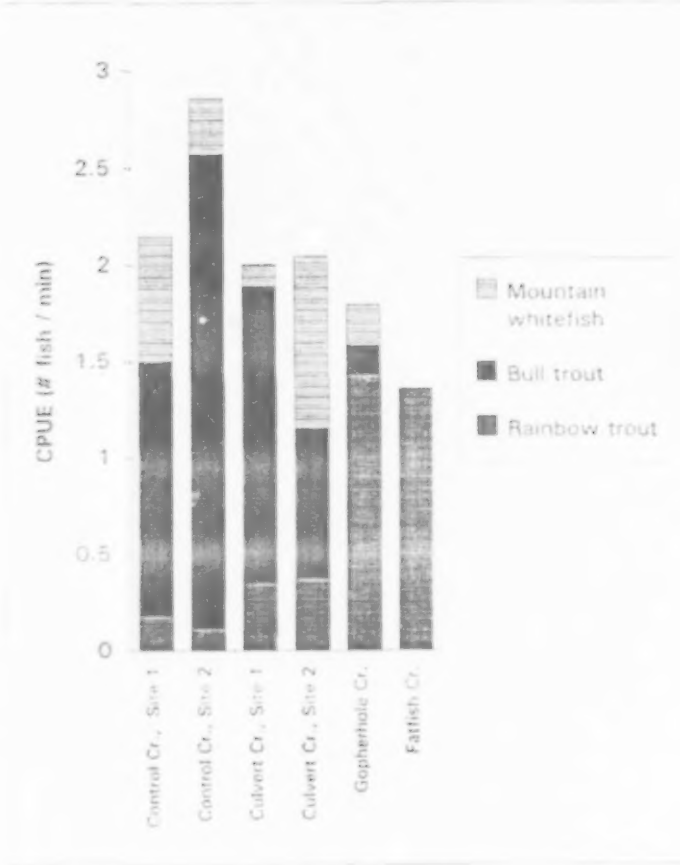


Figure 35. Catch per unit effort (CPUE), electrofishing in Mesilinka tributaries, 1993.

APPENDIX A

Table A1. Weather data at Germansen Landing weather station.

	Mean Temp. (deg. C.)			Total Precipitation (mm)		
	1992	1993	Ave. 1961-90	1992	1993	Ave. 1961-90
May	6.7	11.1	7.2	29.3	34.0	40.5
Jun	13.7	11.8	11.5	17.0	105.8	58.4
Jul	15	13.4	13.8	20.6	107.0	55.9
Aug	13.2	13.7	12.9	6.3	60.0	46.3
Sep	6.4	9.7	8.2	104.5	12.6	46.9
			May-Aug total:	73.2	306.8	201.1
			May-Sep total:	177.7	319.4	248.0

- weather station is located on the Omenica River, 55 km due south of Mesilinka River, Reach T2.

Table A2. Mesilinka River, mean monthly flows (m3/s), at WSC station, above Gopherhole Creek at WSC station 07EC003.

	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	10 year mean 1982-91
Apr	8.2	12.6	10.2	7.1	5.0	8.0	13.2	12.3	10.4	12.8	21.4	12.7	10.5
May	39.9	68.1	40.6	60.7	36.2	81.4	119.0	94.9	95.3	102.0	77.5	132.0	73.8
Jun	210.0	164.0	182.0	128.0	165.0	226.0	182.0	148.0	264.0	137.0	251.0	115.0	180.6
Jul	118.0	111.0	126.0	116.0	119.0	130.0	110.0	65.9	105.0	79.2	83.7	73.7	108.0
Aug	56.5	54.2	73.4	38.3	43.8	53.1	51.4	41.9	36.0	39.8	29.9	53.4	48.8
Sept	41.9	35.2	41.5	37.6	27.5	55.1	25.4	26.2	23.0	37.7	31.5	30.3	35.1
Oct	33.2	25.1	45.8	24.6	39.7	39.4	31.7	29.1	14.5	39.8	49.5	19.9	32.3
Total flow, April - Oct:	507.7	470.2	519.5	412.3	439.2	593.0	532.7	418.3	548.2	448.3	524.5	437.0	488.9

Table A3. Nation River flows (m3/sec) at WSC station 07ED003, "near mouth", compared to the Mesilinka River 10 y means.

	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	Nation R. 1982-91	Mesilinka 1982-91
April	16.3	51.5	34.0	20.2	20.1	28.0	44.2	39.3	44.8	44.7	135.0	52.0	34.3	10.28
May	183.0	227.0	214.0	189.0	139.0	268.0	412.0	258.0	262.0	293.0	321.0	321.0	244.5	73.81
June	397.0	172.0	366.0	247.0	434.0	294.0	349.0	144.0	346.0	184.0	342.0	182.0	293.3	180.6
July	140.0	144.0	151.0	87.2	150.0	91.8	94.0	55.0	88.3	75.0	84.7	106.0	107.6	108
August	67.9	62.1	42.6	27.8	41.8	35.1	37.9	25.9	27.2	27.3	23.0	74.4	39.6	48.84
September	42.3	34.6	36.4	23.6	20.0	21.9	20.5	15.0	18.6	33.8	22.5	42.8	26.7	35.11
October	45.6	31.7	56.3	25.2	32.9	21.4	25.6	17.6	18.9	41.0	62.6	27.6	31.6	32.29
Total flow (Apr - Oct):	892.1	722.9	900.3	620.0	837.8	760.2	983.2	554.8	805.8	698.8	990.8	805.8	777.6	488.9

- Mesilinka flows measured at WSC station 07EC003, "above Gopherhole Creek".

Table A4. Nation R., comparison of mean monthly flows (m3/s) at 2 WSC stations.

	Nation River, below Chuchi Lake WSC stn 07ED001		Nation River, near mouth WSC stn 07ED003	
	1992	1993	1992	1993
Apr	65.3	21.1	135.0	52.0
May	221.0	233.0	321.0	321.0
Jun	293.0	145.0	342.0	182.0
Jul	71.9	79.3	84.7	106.0
Aug	14.9	55.6	23.0	74.4
Sep	11.3	33.5	22.5	42.8
Oct	39.7	19.9	62.6	27.6
Total flow (Apr - Oct):	717.1	587.4	990.8	805.8

- WSC, Water Survey of Canada hydrograph station

Table A5. Mean temperatures (degrees C), Mesilinka and Nation rivers 1992-93, and Mesilinka tributa

	1992				
	Jul	Aug	Sep	Jul-Sep	Recording period
Control (Blackpine) (upper)	11.6	12.1	8.3	11.2	Jun 28 - Sep 13
T1 reach (mid)	11.8	12.1	7.8	11.2	Jun 28 - Sep 13
Below T2 (T. Gratton's) (lower)	12.6	12.8	8.5	12	Jun 28 - Sep 12
Nation R.	16.9	16.8	-	-	Jul 19 - Aug 31

	1993					
	Jun	Jul	Aug	Sep	Jun-Sep	Recording period
Control (Blackpine)	9.2	11.2	11.9	10.7	11	Jun 14 - Sep 7
Below T2 (T. Gratton's)	9.6	11.5	12.1	11.3	11.4	Jun 17 - Sep 7
Carina Cr.	12	13.6	14.4	12.6	13.5	Jun 16 - Sep 14
Control Cr.	5.8	7.4	8.2	7.7	7.4	Jun 13 - Sep 7
Culvert Cr.	6.5	8.2	9	8.4	8.1	Jun 13 - Sep 7
Gopherhole Cr.	6.7	8.3	9.1	8.4	8.3	Jun 15 - Sep 7
Nation R.	-	14.4	15.4	-	-	Jun 30 - Aug 31

- from Langston (1993a, 1993b)

Table A6. Water Quality Mesilinka Fertilization Project 1992.

	Mesilinka Sites			Mesilinka	Mesilinka Tributary Creeks			
	Blackpine	T1	T2	mean	Culvert	Gopherhole	Control	Canna
NO3-NO2 (ug/L)								
28-Jun						<5		6
20-Jul	27	15	19	19	15	5	28	<5
23-Aug	17	19	22	18	34	22	41	<5
13-Sep	14	15	26	15	13	9	29	<5
NH3-N (ug/L)								
20-Jul	18	6	11	11	11	26	5	8
23-Aug	9	15	11	11	22	13	17	36
13-Sep	<5	<5	<5	<5	<5	<5	<5	6
TON (ug/L)								
20-Jul	60	60	280	60	120	110	80	130
23-Aug	40	50	60	50	70	110	70	40
13-Sep	70	100	40	70	<40	<40	<40	<40
SRP (ug/L)						1		1
20-Jul	<1	<1	<1	<1	<1	<1	<1	<1
23-Aug	<1	1	<1	<1	<1	<1	<1	<1
13-Sep	<1	1	1	1	1	1	1	1
TDP (ug/L)								
20-Jul	8	<3	7	7	<3	<3	<3	<3
23-Aug	<3	<3	<3	<3	<3	<3	<3	<3
13-Sep	<3	<3	<3	<3	<3	<3	<3	<3
TDS (mg/L)								
20-Jul		68	48	72				
23-Aug		78	82	74				
13-Sep		72	84	90				
Alkalinity (mg/L)								
20-Jul		29.1	42	45.1				
23-Aug		42.4	53.7	55.8				
13-Sep		42.4	52.9	60.2				
pH								
20-Jul		7.4	7.8	7.8				
23-Aug		7.5	7.9	7.7				
13-Sep		7.5	7.8	7.8				

Gratton's	NFR (mg/L)	Turbidity (NTU)	Secchi depth (m)
27-Jun	24	5	0.7
3-Jul	18	2.7	0.9
10-Jul	16	1.5	1
17-Jul	18	2.6	1.1
24-Jul	30	2.6	2
31-Jul	5	2.9	–

Minimum Detection Limits (MDL)

NO3-NO2	nitrate-nitrite nitrogen	5 ug/L
NH3-N	ammonium -nitrogen	5 ug/L
TON	Total organic nitrogen	40 ug/L
SRP (ortho-P)	Soluble reactive phosp.	1 ug/L
TDP	Total dissol. phosphorous	3 ug/L
NFR	Nonfilterable residue	4 mg/L
Turbidity		0.1 NTU

- soluble reactive phosphorous is also called ortho-phosphorous.

- NO3-NO2 in normal (oxygenated) river systems in mostly N03 (nitrate).

Table A7. Water Quality Mesilinka Fertilization Project 1993.

	Mesilinka sites						Mesilinka Tributary Creeks						
	Jackpin	Roaden	T1	T2	Gratton's Camp	Nation R	Site 2 Culvert	Site 1 Culvert	Site 2 Gopherhol	Site 1 Gopherhol	Control	Carina	Fatfish
NO3-NO2 (ug/L)													
28-Jun	9	21	11	23	15			9		6	29	8	30
26-Jul	6	15	11	16		<5	11	5	7		28	<5	30
29-Aug	11		5	13		7	14	13	<5	7	32	5	30
NH3-N (ug/L)													
28-Jun	<5	<5	<5	<5	5			<5		<5	<5	<5	<5
26-Jul	<5	<5	<5	8		<6	7	5	<5	<5	<5	<5	<5
29-Aug	<5	6	<5	6		6	7	6	<5	5	7	6	7
TON (ug/L)													
28-Jun	110	110	90	110	250			210		250	170	170	100
26-Jul	70	100	160	120		160	90	90	140	110	130	110	80
29-Aug	<40	40	50	<40		120	140	170	130	140	120	80	40
SRP (ortho-P) (ug/L)													
28-Jun	<1	<1	<1	1	2			<1		<1	<1	<1	<1
26-Jul	<1	3	2	3		<1	1	1	2	2	5	1	3
29-Aug	<1	<1	<1	<1		<1	1	1	2	<1	1	1	2
TDP (ug/L)													
28-Jun	3	<3	6	6	5			4		4	<3	<3	<3
29-Aug	<3	<3	<3	<3		4	<3	<3	<3	<3	<3	<3	<3
NFR (mg/L)													
28-Jun	<4	5	<4	10	17			12		13	8	15	<4
26-Jul	<4	<4	<4	7		25	<4	<4	5	<4	<4	7	<4
29-Aug													
Turbidity (NTU)													
28-Jun	0.3	0.6	0.9	1.4	2.8			0.8		0.7	0.6	1.3	0.6
26-Jul	0.1	0.3	0.2	0.5		0.5	0.1	0.2	0.1	0.2	0.3	0.3	0.4

Gratton's Camp	NFR (mg/L)	Turbidity (NTU)	Secchi epth (m)
12-Jun	6	0.9	1.5
19-Jun	<4	0.6	1.6
27-Jun	<4	0.2	2
28-Jun	17	2.8	-
3-Jul	4	0.6	1.7
10-Jul	4	0.6	1.7
17-Jul	<4	0.4	
24-Jul	<4	0.4	-
31-Jul	4	1.1	1.2

Minimum Detection Limits (MDL)		
NO3-NO2	nitrate-nitrite nitrogen	5 ug/L
NH3-N	ammonium nitrogen	5 ug/L
TON	Total organic nitrogen	40 ug/L
SRP (ortho-P)	Soluble reactive phosphate	1 ug/L
TDP	Total dissolved phosphorous	3 ug/L
NFR	Nonfilterable residue	4 mg/L
Turbidity		0.1 NTU

- soluble reactive phosphorous is also called ortho-phosphorous.
- NO3-NO2 in normal (oxygenated) river systems in mostly N03 (nitrate).
- Site 1: downstream sites in Culvert and Gopherhole creeks.
- Site 2: upstream sites in Culvert and Gopherhole creeks.

Table A8. Mesilinka and Nation R., rainbow trout data (age, length and weight) 1992.

Mesilinka River length at age (mm), rainbow trout

Age	Minimum	Average	Maximum	# fish	% Composition
2+	127	167.4	216	26	14
3+	152	216.0	281	83	46
4+	190	264.9	310	45	25
5+	280	317.4	345	17	9
6+	288	313.4	356	8	4
7+	342	342.0	342	1	1
			total:	180	100

Mesilinka River weight at age (g), rainbow trout

Age	Minimum	Average	Maximum	# fish	% Composition
2+	28	58.9	113	26	14
3+	57	131.3	284	83	46
4+	85	216.0	312	45	25
5+	227	321.9	454	17	9
6+	255	361.6	511	8	4
7+	397	397.0	397	1	1
			total:	180	100

Nation River length at age, rainbow trout

Age	Minimum	Average	Maximum	# fish	% Composition
2+	150	175.5	202	4	12
3+	171	223.0	255	17	50
4+	249	277.6	300	8	24
5+	280	294.7	302	3	9
6+	297	298.5	300	2	6
			total:	34	100

Nation River weight at age, rainbow trout

Age	Minimum	Average	Maximum	# fish	% Composition
2+	50	90.3	113	4	12
3+	85	170.6	320	17	50
4+	198	268.6	369	8	24
5+	284	321.7	369	3	9
6+	284	284.0	284	2	6
			total:	34	100

Table A9. Mesilinka and Nation River (catchable) grayling data (age, length and weight) 199

Mesilinka River grayling, length at age (mm)

Age	Minimum	Average	Maximum	Std. Error	# fish	% Composition
2+	190	195.3	204	4.4	3	3.0
3+	210	257.1	302	3.3	28	28.3
4+	250	300.0	345	3.6	31	31.3
5+	290	331.8	373	4.1	21	21.2
6+	330	361.9	390	6.9	9	9.1
7+	360	376.2	395	6.6	5	5.1
8+	350	362.0	374	12.0	2	2.0
				total:	99	100

Mesilinka River grayling, weight at age (g)

Age	Minimum	Average	Maximum	Std. Error	# fish	% Composition
2+	85	113.3	142	16.5	3	3.0
3+	113	188.9	340	9.2	28	28.3
4+	170	317.4	454	11.2	31	31.3
5+	284	421.4	511	13.0	21	21.2
6+	198	502.2	681	47.9	9	9.1
7+	454	553.0	681	37.0	5	5.1
8+	482	510.5	539	28.5	2	2.0
				total:	99	100

Nation River grayling, length at age (mm)

Age	Minimum	Average	Maximum	Std. Error	# fish	% Composition
1+	149	153.0	157	4.0	2	2.6
2+	222	235.5	245	3.1	6	7.7
3+	261	280.7	300	1.9	29	37.2
4+	278	316.9	349	2.5	31	39.7
5+	320	331.1	343	2.4	10	12.8
				total:	78	100

Nation River grayling, weight at age (g)

Age	Minimum	Average	Maximum	Std. Error	# fish	% Composition
1+	28	54.0	80	26.0	2	2.6
2+	142	185.3	220	12.1	6	7.7
3+	200	287.7	350	7.2	29	37.2
4+	255	394.8	500	11.4	31	39.7
5+	340	426.0	510	17.6	10	12.8
				total:	78	100

Table A10. Mesilinka and Nation River rainbow trout data (age, length and weight) 1993.

Mesilinka River rainbow trout, length at age (mm)

Age	Minimum	Average	Maximum	Std. Error	# fish	% Composition
0+	38	48.8	54	1.5	13	n/a
1+	96	116.0	153	18.5	3	n/a
2+	134	161.3	200	2.9	31	33.3
3+	181	225.6	271	4.6	29	31.2
4+	154	268.3	331	8.7	24	25.8
5+	211	290.3	326	12.5	8	8.6
6+	310	310.0	310	n/a	1	1.1
				(2+ to 6+):	93	100.0

Mesilinka River rainbow trout, weight at age (g)

Age	Minimum	Average	Maximum	Std. Error	# fish	% Composition
0+	0.6	1.4	2.5	1.5	13	n/a
1+	10.5	20.5	40	9.8	3	n/a
2+	28	69.5	170	6.0	31	33.3
3+	57	139.7	284	10.0	29	31.2
4+	57	231.6	369	16.9	24	25.8
5+	85	280.0	340	29.6	8	8.6
6+	482	482.0	482	n/a	1	1.1
				(2+ to 6+):	93	100.0

Nation River rainbow trout, length at age (mm)

Age	Minimum	Average	Maximum	Std. Error	# fish	% Composition
2+	127	159.0	201	4.3	20	19.4
3+	185	232.3	272	3.5	44	42.7
4+	201	267.5	340	6.4	31	30.1
5+	265	283.4	308	6.0	8	7.8
				total:	103	100

Nation River rainbow trout, weight at age (g)

Age	Minimum	Average	Maximum	Std. Error	# fish	% Composition
2+	16	69.1	280	12.3	20	19.4
3+	70	169.5	272	6.9	44	42.7
4+	113	233.1	320	9.3	31	30.1
5+	227	269.0	350	15.5	8	7.8
				total:	103	100

- percent composition only calculated for rainbow trout large enough to be caught by angling, (age 2+ to 6+).
- most angled fish caught in July and August.

Table A11. Mesilinka and Nation River grayling data (age, length and weight) 1993.

Mesilinka River grayling, length at age (mm)

Age	Minimum	Average	Maximum	Std. Error	# fish	% Composition
2+	118	185.0	218	9.3	9	16.4
3+	244	275.8	367	19.2	6	10.9
4+	255	299.2	342	4.5	21	38.2
5+	305	331.5	360	5.3	10	18.2
6+	312	358.0	380	10.3	6	10.9
7+	370	370.0	370	n/a	1	1.8
8+	352	365.0	378	13.0	2	3.6
				total:	55	100

Mesilinka River grayling, weight at age (g)

Age	Minimum	Average	Maximum	Std. Error	# fish	% Composition
2+	57	94.6	142	11.5	9	16.4
3+	170	211.2	304	20.5	6	10.9
4+	170	304.8	425	14.6	21	38.2
5+	227	371.6	511	31.0	10	18.2
6+	312	458.7	596	44.2	6	10.9
7+	482	482.0	482	n/a	1	1.8
8+	284	417.0	550	133.0	2	3.6
				total:	55	100

Nation River grayling, length at age (mm)

Age	Minimum	Average	Maximum	Std. Error	# fish
1+	141	141.0	141	n/a	1
2+	226	226.0	226	n/a	1
3+	284	287.0	290	n/a	2
					4

Nation River grayling, weight at age (g)

Age	Minimum	Average	Maximum	Std. Error	# fish
1+	25	25.0	25	n/a	1
2+	180	180.0	180	n/a	1
3+	300	300.0	300	0.0	2
					4

Additional Nation River grayling (5 fish), no age determination

Length (mm)	Weight (g)	Length (mm)	Weight (g)
140	50	250	100
191	100	289	300
232	-		

- all fish caught by angling, and therefore no smaller sizes.

Table A12. Mesilinka River swim counts, Control (Blackpine) reach, 1992.

Mesilinka River Swim Count 1992 — Control Reach

Visibility 4.2 m — Length of Reach = 7.5 km — Ave. width = 37.6 m — Area = 28.2 ha — # Swimmers = 8 — Date, swim 1: Aug 22, 92 — Date, swim 2: Aug 23, 92

Swim #1

	0-10 cm			10-20 cm			20-30 cm						30-40 cm						40-50 cm						50-60 cm		60-70 cm		total	total	total	total	total	total
							rbt		gray		bull		rbt		gray		bull		rbt		gray		bull		bull		bull		rbt	gray	bull	rb,gr &bull	wht	schr	sqsw
Lane	rbt	gray	bull	rbt	gray	bull	tags	rbt	tags	gray	tags	bull	tags	rbt	tags	gray	tags	bull	tags	rbt	tags	gray	tags	bull	tags	bull	tags	bull	tags						
RS	1	0	0	0	0	0	1	0	1	0	0	0	1	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	3	3	0	6	10	2	0
RNS	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	2r	0	0	0	0	1	0	0	0	0	0	0	0	1	8	0	9	15	1	0
RM	0	0	0	0	1	0	0	0	4	1g	0	0	0	0	6	2g,1r	1	0	0	0	0	0	0	0	0	0	1	0	0	11	2	13	310	2	0
LM	0	0	0	1	0	0	0	0	0	0	0	0	0	0	10	4r	0	0	0	0	0	0	0	0	0	0	0	0	1	18	0	19	39	3	0
LNS	0	0	0	0	0	0	1	0	0	0	0	0	0	0	5	2r	0	0	0	0	0	0	0	0	0	0	0	0	1	5	0	6	70	1	0
LS	0	0	0	0	1	0	0	0	1	0	0	0	0	0	8	1g,4r	0	0	0	0	1	0	1	0	1	0	0	0	0	11	2	13	40	0	0
Total	1	0	0	1	2	0	2		6		0		2		40		1		0		4		1		1		1		6	56	4	66	493	9	0

Swim #2

	0-10 cm			10-20 cm			20-30 cm						30-40 cm						40-50 cm						50-60 cm		60-70 cm		total	total	total	total	total	total
							rbt		gray		bull		rbt		gray		bull		rbt		gray		bull		bull		bull		rbt	gray	bull	rb,gr &bull	wht	schr	sqsw
Lane	rbt	gray	bull	rbt	gray	bull	tags	rbt	tags	gray	tags	bull	tags	rbt	tags	gray	tags	bull	tags	rbt	tags	gray	tags	bull	tags	bull	tags	bull	tags						
RS	0	0	0	4	1	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	8	5	5	0
RNS	0	0	0	0	0	0	2	0	1	0	0	0	0	0	1	1g	0	0	0	0	0	0	0	0	0	0	1	0	0	0	2	2	1	5	225	3	0
RM	0	1	0	0	0	0	1	0	2	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	1	4	1	6	304	48	0
LM	0	0	0	0	0	0	0	0	5	1r	0	0	0	0	1	1g	0	0	0	0	2	0	0	0	0	0	0	0	0	12	0	12	107	0	0
LNS	0	0	0	0	0	0	2	0	5	1g	0	0	1	1r	8	3r	0	0	0	0	0	0	0	0	0	0	0	0	3	13	0	16	190	1	0
LS	0	0	0	0	0	0	0	0	0	0	0	0	3	1g	2	1r	0	0	0	0	0	0	1	0	0	0	0	0	3	2	1	6	40	1	0
Total	0	1	0	4	1	0	7		13		0		4		13		2		0		2		1		1		0		15	38	4	55	861	56	0

SUMMARY

Expansion factor: 1.74 = Total mid-channel width/mid-channel width covered.

Expanded Results	0-10 cm			10-20 cm			20-30 cm			30-40 cm			40-50 cm			50-60 cm	60-70 cm	total	total	total	total rb,gr	total	total	total
	rbt	gray	bull	rbt	gray	bull	rbt	gray	bull	rbt	gray	bull	rbt	gray	bull	bull	bull	rbt	gray	bull	&bull	wht	schr	sqsw
Total for swim 1	1	0	0	2	3	0	3	9	0	3	71	2	0	5	1	1	2	8	87	5.5	103	813	14	0
Total for swim 2	0	1	0	4	1	0	11	23	0	5	32	3	0	3	1	2	0	19	60	5.5	95	1483	93	0
Mean, swim 1&2	0.5	0.5	0.0	3.0	1.0	0.0	6.7	15.5	0.0	3.7	51.1	2.2	0	4.1	0.0	1.4	0.5	13.8	73.7	5.5	99.0	1138	53.5	0.0
Standard Error	0.5	0.5	0.5	1.1	0.5	0.5	4.0	6.8	0.0	1.0	19.5	0.5	0.0	1.63	0.0	0.4	0.5	5.6	13.3	0.0		325.0	33.4	0.0
Median	0.1	0.1	0.0	0.4	0.2	0.0	0.9	2.1	0.0	0.5	6.8	0.3	0	0.5	0.1	0.2	0.1	1.8	9.8	0.7	12.4	151.8	7.1	0.0
Standard Error	0.07	0.12	0.00	0.15	0.12	0.00	0.53	0.91	0.02	0.13	2.60	0.07	0.00	0.06	0.00	0.05	0.12	0.75	1.78	0.00		43.33	5.25	0.00
Maxcha	0.02	0.03	0.0	0.1	0.1	0.0	0.2	0.6	0.0	0.1	1.8	0.1	0.0	0.1	0.04	0.05	0.03	0.5	2.6	0.2	3.3	40.4	1.9	0.0
Standard Error	0.02	0.03	0.00	0.04	0.03	0.00	0.14	0.24	0.00	0.04	0.69	0.02	0.00	0.02	0.003	0.01	0.01	0.20	0.47	0.00		11.52	1.40	0.00

Equal & > 20 cm				
total rbt	total gray	total bull	total
5.0	84.0	5.5	95
15.0	58.0	5.5	79
10.5	70.9	5.5	87
5.0	13.3	0.0	
1.4	9.5	0.7	11.6
0.66	1.78	0.00	
0.4	2.5	0.2	3.1
0.18	0.47	0.00	

Total count for each swim was obtained by expanding the out lane count (sum RNS, RM, LM, and LNS) x exp. factor, and adding the shore fans (RS, LS) counts.

All mountain whitefish, sucker and squawfish counts are restricted to individuals equal and more than 20 cm in length.

A table is included (lower right side) with total rainbow trout, arctic grayling and bull trout equal and more than 20 cm in order to compare the swim counts with mark-recapture estimates.

RS - Right shore — RM - Right mid-channel — LNS - Left near shore — rbt or rb - rainbow trout — bull - bull trout — schr - bucket species

RNS - Right near shore — LM - Left mid-channel — LS - Left shore — gray or gr - grayling — wht - mountain whitefish — sqsw - squawfish

Table A13. Mesilinka River swim counts, Reach T1, 1992

Mesilinka River Swim Count 1992 — **Reach T1**

Visibility 4.0 m — Length of Reach = 7.2 km — Ave width = 40.8 m — Area = 29.4 ha — # Swimmers = 6 — Date, swim 1: Aug 20, 92 — Date, swim 2: Aug 21, 92

Swim #1

Lane	0-10 cm rbt	0-10 cm gray	0-10 cm bull	10-20 cm rbt	10-20 cm gray	10-20 cm bull	20-30 cm rbt	20-30 cm rbt tags	20-30 cm gray	20-30 cm gray tags	20-30 cm bull	20-30 cm bull tags	30-40 cm rbt	30-40 cm rbt tags	30-40 cm gray	30-40 cm gray tags	30-40 cm bull	30-40 cm bull tags	40-50 cm rbt	40-50 cm rbt tags	40-50 cm gray	40-50 cm gray tags	40-50 cm bull	40-50 cm bull tags	50-60 cm bull	50-60 cm bull tags	60-70 cm bull	60-70 cm bull tags	total rbt	total gray	total bull	total rb,gr &bull	total wht	total ackr	total sqew
RS	0	0	0	0	0	0	5	2r	1	0	1	0	4	0	1	0	1	0	0	0	0	0	0	0	1	1r	0	0	9	2	3	14	38	0	0
RNS	0	0	0	0	2	0	1	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	2	3	0	5	9	2	0
RM	0	0	0	0	1	0	0	0	9	0	0	0	1	1r	5	0	1	0	0	0	1	0	1	0	0	0	0	0	1	16	2	19	152	0	0
LM	0	0	0	0	0	0	2	0	2	0	1	0	0	0	15	1r	0	0	0	0	1	0	0	0	0	0	0	0	2	18	1	21	110	4	0
LNS	0	0	0	0	0	0	2	0	11	0	0	0	1	0	13	1g 1r	0	0	0	0	1	0	1	0	0	0	0	0	3	27	6	36	206	2	0
LS	0	0	0	1	0	0	9	0	0	0	1	0	2	2r	4	1r	1	1r	0	0	0	0	0	0	1	0	1	0	12	6	4	22	136	8	0
Total	0	0	0	1	3	0	19		23		3		9		41		3		0		5		2		2		1		29	72	16	117	648	16	0

(wht - 1r tag)

swim 1 - one burbot in LS

Swim #2

Lane	0-10 cm rbt	0-10 cm gray	0-10 cm bull	10-20 cm rbt	10-20 cm gray	10-20 cm bull	20-30 cm rbt	20-30 cm rbt tags	20-30 cm gray	20-30 cm gray tags	20-30 cm bull	20-30 cm bull tags	30-40 cm rbt	30-40 cm rbt tags	30-40 cm gray	30-40 cm gray tags	30-40 cm bull	30-40 cm bull tags	40-50 cm rbt	40-50 cm rbt tags	40-50 cm gray	40-50 cm gray tags	40-50 cm bull	40-50 cm bull tags	50-60 cm bull	50-60 cm bull tags	60-70 cm bull	60-70 cm bull tags	total rbt	total gray	total bull	total rb,gr &bull	total wht	total ackr	total sqew
RS	0	0	0	0	0	0	0	0	3	0	0	0	2	0	2	0	0	0	0	0	0	0	1	0	0	0	0	0	2	5	1	8	35	0	0
RNS	0	0	0	0	1	0	0	0	1	0	1	0	3	2r	1	0	0	0	1	0	1	0	1	0	0	0	0	0	4	4	2	10	48	1	0
RM	0	1	0	0	0	0	0	0	5	4g	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7	0	7	106	2	0
LM	0	0	0	0	0	0	0	0	0	0	0	0	2	0	3	1r	1	0	0	0	0	0	0	0	0	0	0	0	2	3	1	6	146	3	0
LNS	0	0	0	0	0	0	3	0	6	0	1	0	4	0	2	1r	0	0	0	0	1	0	2	0	0	0	0	0	7	16	3	26	89	7	0
LS	0	0	0	1	1	0	12	1r	1	0	1	0	7	1r	4	0	1	0	0	0	0	0	3	0	1	0	0	0	20	6	6	32	253	0	0
Total	0	1	0	1	2	0	15		16		3		19		20		2		1		2		7		1		0		35	41	13	89	677	13	0

(wht - 1r tag)

SUMMARY

Expansion factor = 2.05 = Total mid channel width/mid channel width covered

Expanded Results	0-10 cm rbt	0-10 cm gray	0-10 cm bull	10-20 cm rbt	10-20 cm gray	10-20 cm bull	20-30 cm rbt	20-30 cm gray	20-30 cm bull	30-40 cm rbt	30-40 cm gray	30-40 cm bull	40-50 cm rbt	40-50 cm gray	40-50 cm bull	50-60 cm bull	50-60 cm bull tags	60-70 cm bull	60-70 cm bull tags	total rbt	total gray	total bull	total rb,gr &bull	total wht	total ackr	total sqew
Total for swim 1	0	0	0	1	5	0	24	48	4	12	77	14	0	10	4	2	1	37	139	25	202	1148	24	0		
Total for swim 2	0	2	0	1	3	0	18	29	5	27	35	3	2	4	10	1	0	49	73	19	140	1085	27	0		
Mean, swim 1&2	0.0	1.0	0.0	1.0	4.0	0.0	21.2	37.4	4.6	19.8	55.7	8.7	1.1	7.2	7.1	1.5	0.5	43.0	106	22.4	171	1117	25.5	0		
Standard Error	0.0	1.0	0.0	0.0	1.6	0.0	3.0	8.8	0.5	7.7	21.0	5.5	1.0	1.08	3.0	0.5	0.5	5.5	33.4	3.1		31.2	1.1	0		
Mean/km	0.0	0.1	0.0	0.1	0.6	0.0	2.9	5.2	0.6	2.8	7.7	1.2	0.1	1.0	1.0	0.2	0.1	6.0	14.7	3.1	23.8	155.1	3.5	0		
Standard Error	0.00	0.14	0.00	0.00	0.22	0.00	0.42	1.22	0.07	1.06	2.92	0.76	0.14	0.43	0.42	0.07	0.07	0.8	4.6	0.4		4.3	0.2	0		
Mean/ha	0.00	0.0	0.0	0.0	0.2	0.0	0.7	1.3	0.2	0.7	1.9	0.3	0.03	0.2	0.2	0.05	0.02	1.5	3.6	0.8	5.8	38.0	0.9	0		
Standard Error	0.00	0.03	0.00	0.00	0.05	0.00	0.10	0.30	0.02	0.26	0.71	0.19	0.03	0.10	0.10	0.02	0.02	0.19	1.14	0.10		1.06	0.04	0		

Equiv. & > 20 cm	total rbt	total gray	total bull	total
	38	133	25	194
	48	67	19	134
	42	100	22	165
	9.6	32.8	3.1	
	8.8	13.9	3.1	22.8
	0.8	4.6	0.4	
	1.4	3.4	0.8	5.6
	0.19	1.12	0.10	

total count for each swim was obtained by expanding the mid lane count (sum RNS, RM, LM, and LNS x exp. factor), not adding the shoreline (RS, LS) counts.

all mountain whitefish, suckers and squawfish counts are restricted to individuals equal and more than 20 cm in length.

a table is included (lower right side) with total rainbow trout, arctic grayling and bull trout equal and more than 20 cm in order to compare the swan counts with mark recapture estimates.

RS - Right shore — RM - Right mid-channel — LNS - Left near shore — bull - bull trout — ackr - number species

RNS - Right near shore — LM - Left mid-channel — LS - Left shore — wht - mountain whitefish — sqew - squawfish

Table A14 Mesilinka River swim counts, Reach T2, 1992

Mesilinka River Swim Count 1992 — Reach T2

Visibility 4.0 m — Length of Reach = 9.1 km — Ave. width = 38.7 m — Area = 31.2 ha — # Sections = 6 — Date, swim 1: Aug 18, 92 — Date, swim 2: Aug 19, 92

Swim #1

Lane	0-10 cm rbt	0-10 cm gray	0-10 cm bull	10-20 cm rbt	10-20 cm gray	10-20 cm bull	20-30 cm rbt tags	20-30 cm gray tags	20-30 cm bull tags	30-40 cm rbt tags	30-40 cm gray tags	30-40 cm bull tags	40-50 cm rbt tags	40-50 cm gray tags	40-50 cm bull tags	50+ cm bull tags	total rbt	total gray	total bull	total rb,gr &bull	total wht	total sckr	total sqaw
RS	0	0	0	3	1	1	8 0	2 0	1 0	1 0	4 0	5 0	0 0	1 0	3 1+	1 0	12	8	6	26	13	2	0
RNS	0	0	0	0	3	0	4 1g	9 0	1 0	1 0	0 0	0 0	0 0	0 0	0 0	0 0	5	12	1	18	27	21	0
RM	0	0	0	4	1	0	2 0	1 0	1 0	0 0	0 0	4 0	0 0	0 0	1 0	0 0	6	7	6	14	42	34	0
LM	0	0	0	1	0	0	1 0	1 1g	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	2	1	0	3	20	25	0
LNS	0	0	0	0	1	0	6 1+	2 0	2 0	1 1+	0 0	0 0	0 0	0 0	0 0	0 0	7	3	2	12	7	10	0
LS	0	0	0	10	2	0	8 3+	3 0	0 0	2 1+	3 0	1 0	0 0	6 0	1 0	0 0	20	8	2	30	27	1	0
Total	0	0	0	18	8	1	29	18	5	5	7	5	0	1	5	1	52	34	17	103	136	93	0

0 - 10 cm not counted in Swim 1 — 40 + gray!

Swim #2

Lane	0-10 cm rbt	0-10 cm gray	0-10 cm bull	10-20 cm rbt	10-20 cm gray	10-20 cm bull	20-30 cm rbt tags	20-30 cm gray tags	20-30 cm bull tags	30-40 cm rbt tags	30-40 cm gray tags	30-40 cm bull tags	40-50 cm rbt tags	40-50 cm gray tags	40-50 cm bull tags	50+ cm bull tags	total rbt	total gray	total bull	total rb,gr &bull	total wht	total sckr	total sqaw
RS	0	0	0	7	2	0	13 2+	3	0 1 0	6 2+	4	0 1 0	3	0	0 2	0 1	26	9	5	40	7	1	0
RNS	0	10	0	1	0	0	3 0	2	0 0 0	0 0	0	1 0	0	0	0 1	0 0	4	12	2	18	15	1	0
RM	1	0	0	0	0	0	0 0	3	1+ 0 0	0 0	0	2 0	0	0	1 0	0 0	1	3	3	7	41	65	0
LM	0	0	0	0	1	0	0 0	4	0 0 0	0 0	1	0 1	0	0	1 0	0 0	0	6	2	8	67	4	0
LNS	0	0	0	4	2	0	13 1+	7	0 2 0	6 2+	2	0 2	0	0	0 0	0 0	23	11	7	41	35	12	0
LS	0	0	0	3	6	0	17 1g,3+	2	0 1 0	6 5+	1	0 2	0	0	0 0	0 0	26	9	3	38	63	1	0
Total	1	10	0	15	11	0	46	21	4	16	8	5	0	0	7	2	80	50	22	152	222	84	0

Note: one bullhot, > 50 cm, in LNS swim 2! observed

SUMMARY

Expansion factor = 1.92 = Total mid channel width/mid channel width covered

Expanded Results	0-10 cm rbt	0-10 cm gray	0-10 cm bull	10-20 cm rbt	10-20 cm gray	10-20 cm bull	20-30 cm rbt	20-30 cm gray	20-30 cm bull	30-40 cm rbt	30-40 cm gray	30-40 cm bull	40-50 cm rbt	40-50 cm gray	40-50 cm bull	50+ cm bull	total rbt	total gray	total bull	total rb,gr &bull	total wht	total sckr	total sqaw
Total for swim 1	0	0	0	23	13	1	41	30	8	7	7	9	0	1	0	1	72	51	25	146	224	176	0
Total for swim 2	2	19	0	20	14	0	61	36	8	24	11	15	0	0	12	3	106	79	35	220	371	159	0
Mean, swim 1&2	1.0	9.5	0.0	21.1	13.2	0.5	50.8	32.8	7.3	15.2	8.9	11.5	0.0	0.5	6.5	2.0	88.1	65.0	30.1	183	298	168	0
Standard Error	1.0	9.5	0.0	1.5	0.5	0.5	5.9	2.9	1.4	8.5	1.9	2.9	0.0	0.5	2.9	1.0	17.7	14.4	4.80		73.3	8.2	0
Meanlbs	0.1	1.2	0.0	2.6	1.6	0.1	6.3	4.1	0.9	1.9	1.1	1.4	0.0	0.1	1.1	0.2	10.9	8.0	3.7	22.6	36.7	20.7	0
Standard Error	0.12	1.18	0.00	0.19	0.07	0.05	1.22	0.36	0.18	1.03	0.23	0.36	0.00	0.06	0.35	0.12	2.18	1.78	0.59		9.05	1.01	0
Meankg	0.03	0.31	0.00	0.7	0.4	0.02	1.6	1.0	0.2	0.5	0.3	0.4	0.00	0.03	0.3	0.1	2.8	2.1	1.0	5.8	9.5	5.3	0
Standard Error	0.03	0.31	0.00	0.05	0.02	0.02	0.32	0.09	0.05	0.27	0.06	0.09	0.00	0.02	0.09	0.03	0.56	0.46	0.15		2.34	0.26	0

Equal & > 20 cm total rbt	total gray	total bull	total
49	36	24	110
84	46	35	165
66	42	30	138
19.2	4.3	5.3	
8.1	5.2	3.7	17.0
2.3	0.5	0.7	
2.1	1.1	0.9	4.1
0.59	0.14	0.17	

- total count for each swim was collected by expanding the mid lane count (swim #NS, #M, LM, and LNS x exp. factor), and adding the results to the LRS, LS counts
- all mountain whitefish, sucker and squawfish counts are restricted to individuals equal and more than 20 cm in length
- a table is included (lower right side) with total rainbow trout, arctic grayling and bull trout equal and more than 20 cm in order to compare the swim counts with mark-recapture estimates

RS - Right shore — RM - Right midchannel — LNS - Left near shore — rbt or rb - rainbow trout — bull - bull trout — sckr - sucker species
RNS - Right near shore — LM - Left midchannel — LS - Left shore — gray or gr - grayling — wht - mountain whitefish — sqaw - squawfish

Table A15. Mesilinka River swim counts, Control (Blackpine) reach, 1993

Mesilinka River Swim Count 1993 — Reach: Control

Date swim 1: Aug 16 93 — Length of Reach = 7.5 km — Ave. width = 37.6 m — Area = 28.2 ha — # Swimmers = 6 — Visibility, swim 1 (m): 3.60 — Time and Temperature: 12 C at 12:00 h

Date swim 2: Aug 17 93 — Visibility, swim 2 (m): 4.00 — Time and Temperature: 13 C at 10:30 h

Swim #1

	0-10 cm				10-20 cm				20-30 cm						30-40 cm						40-50 cm						50-60 cm	60-70 cm							
									rbt		gray		bull		rbt		gray		bull		rbt		gray		bull		bull	bull	total	total	total	total	total	total	total
Loca	rbt	gray	bull	wht	rbt	gray	bull	wht	rbt	tags	gray	tags	bull	tags	rbt	tags	gray	tags	bull	tags	rbt	tags	gray	tags	bull	tags	wht	bull	tags	bull	tags	rbt	gray	bull	&bull	wht	sckr	sqaw
RS	0	0	0		2	0	0		0	0	1	0	0	0	0	0	0	0	1	1p	0	0	0	0	0	0		0	0	0	0	2	1	1	4	10	2	0
RMS	2	0	0		2	0	1		1	1p	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0	0	0	0	5	1	1	7	60	1	0
RM	0	0	0		7	0	0		1	0	1	0	0	0	0	0	2	2p	0	0	0	0	0	0	0	0		0	0	0	0	3	3	0	6	68	0	0
LM	0	0	0		0	0	0		0	0	0	0	0	0	0	0	5	2x	0	0	0	0	0	0	0	0		0	0	0	0	0	6	0	5	65	0	0
LMS	0	0	0		1	0	0		1	0	1	0	1	0	2	0	5	2p	0	0	0	0	1	0	0	0		0	0	0	0	4	7	1	12	68	0	0
LS	0	0	0		5	0	0		1	0	3	2p	0	0	0	0	4	1p	0	0	0	0	0	0	0	0		1	1g	0	0	8	7	1	14	37	1	0
Total	2	0	0		17	0	1		4		7		1		2		16		1		0		1		0			1		0		20	24	4	48	306	4	0

Swim #2

	0-10 cm				10-20 cm				20-30 cm						30-40 cm						40-50 cm						50-60 cm	60-70 cm							
									rbt		gray		bull		rbt		gray		bull		rbt		gray		bull		bull	bull	total	total	total	total	total	total	total
Loca	rbt	gray	bull	wht	rbt	gray	bull	wht	rbt	tags	gray	tags	bull	tags	rbt	tags	gray	tags	bull	tags	rbt	tags	gray	tags	bull	tags	wht	bull	tags	bull	tags	rbt	gray	bull	&bull	wht	sckr	sqaw
RS	0	0	0		5	0	0		4	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	1p		0	0	0	0	9	1	1	11	40	0	0
RMS	0	0	0		0	0	0		1	0	0	0	0	0	1	0	3	2p	2	0	0	0	0	0	0	0		1	0	0	0	2	3	3	8	78	5	0
RM	0	0	0		0	0	0		0	0	0	0	0	0	1	1p	4	1y,3r	0	0	0	0	0	0	0	0		0	0	1	0	1	4	1	6	57	1	0
LM	0	0	0		0	0	0		0	0	2	1p	0	0	0	0	3	1p	0	0	0	0	0	0	0	0		0	0	0	0	0	5	0	5	43	3	0
LMS	0	0	0		2	0	0		0	0	0	0	0	0	0	0	4	2y,1r	0	0	0	0	1	0	0	0		0	0	0	0	2	5	0	7	101	1	0
LS	1	0	0		3	0	0		1	0	0	0	0	0	1	0	5	1p	0	0	0	0	1	0	0	0		0	0	0	0	9	6	0	15	50	0	0
Total	1	0	0		10	0	0		9		2		0		3		20		2		0		2		1			1		1		23	24	5	52	369	10	0

SUMMARY

Expansion factor, swim 1 = 2.13 = Total wet channel width/and channel width covered

Expansion factor, swim 2 = 1.85 = Total wet channel width/and channel width covered

Expanded Results	0-10 cm				10-20 cm				20-30 cm				30-40 cm				40-50 cm				50-60 cm	60-70 cm							Equiv. A. > 20 cm			
	rbt	gray	bull	wht	rbt	gray	bull	wht	rbt	gray	bull	wht	rbt	gray	bull	wht	rbt	gray	bull	wht	bull	bull	total rbt	total gray	total bull	total rb,gr &bull	total wht	total sckr	total sqaw	total rbt	total gray	total bull	total
Total for swim 1	4	0	0		18	0	2		7	10	2		4	29	1		0	2	0		1	0	33	42	6	81	594	5	0	12	42	4	58
Total for swim 2	1	0	0		12	0	0		10	4	0		5	32	4		0	3	1		2	2	27	38	8	74	606	18	0	15	38	6	61
Mean, swim 1&2	2.6	0.0	0.0		14.6	0.0	1.1		8.6	7.0	1.1		4.9	30.8	2.4		0.0	2.6	0.5		1.4	0.9	30	40	7	78	600	12	0	13	40	6	60
Standard Error	1.6	0.0	0.0		2.9	0.0	1.1		1.3	3.3	1.1		0.2	1.3	1.4		0.0	0.37	0.5		0.4	0.9	3.0	1.7	1.1		8.2	6.7	0.0	1.5	1.7	2.1	
Maximum	0.9	0.0	0.0		2.0	0.0	0.1		1.1	0.9	0.1		0.6	4.1	0.3		0.0	0.3	0.1		0.2	0.1	4.0	5.3	1.0	10.4	80.0	1.6	0.0	1.7	5.3	0.6	7.6
Standard Error	0.21	0.00	0.00		0.33	0.00	0.14		0.17	0.44	0.14		0.03	0.17	0.18		0.00	0.05	0.07		0.06	0.12	0.41	0.22	0.15		0.82	0.89	0.00	0.2	0.2	0.3	
Maximin	0.09	0.0	0.0		0.5	0.0	0.04		0.3	0.2	0.04		0.2	1.1	0.1		0.0	0.1	0.02		0.05	0.03	1.1	1.4	0.3	2.8	21.3	0.4	0.0	0.5	1.4	0.2	2.1
Standard Error	0.06	0.00	0.00		0.10	0.00	0.04		0.04	0.12	0.04		0.01	0.05	0.05		0.00	0.01	0.02		0.02	0.03	0.11	0.08	0.04		0.22	0.24	0.00	0.05	0.06	0.08	

- Immature whitefish were not counted by size category but only by total number per swim (mean) for =
- total count for each swim was obtained by expanding the mid-line count (sum RMS, RM, LM, and LMS) x exp. factor, and adding the shore line (RS, LS) counts
- sucker and squawfish counts are restricted to individuals equal and more than 20 cm in length
- a table is included (lower right side) with total rainbow trout, arctic grayling and bull trout equal and more than 20 cm in order to compare the swim counts with mark recapture estimates

RS - Right shore — RM - Right mid-channel — LMS - Left near shore — rbt - rainbow trout — bull - bull trout — sckr - sucker species

RMS - Right near shore — LM - Left mid-channel — LS - Left shore — gray or gr - grayling — wht - mountain whitefish — sqaw - squawfish

Table A16. Mesilinka River swim counts, Reach 11, 1993

Mesilinka River Swim Count 1993 — Reach 11

Visibility 4 m — Length of Reach = 7.2 km — Av. width = 40.8 m — Area = 294 ha — # Swimmers = 4

Date, swim 1: Aug 18, 93

Date, swim 2: Aug 20, 93

Swim #1

Lane	0-10 cm rbt	0-10 cm gray	0-10 cm bull	0-10 cm wht	10-20 cm rbt	10-20 cm gray	10-20 cm bull	10-20 cm wht	20-30 cm rbt	20-30 cm rbt tags	20-30 cm gray	20-30 cm gray tags	20-30 cm bull	20-30 cm bull tags	20-30 cm wht	30-40 cm rbt	30-40 cm rbt tags	30-40 cm gray	30-40 cm gray tags	30-40 cm bull	30-40 cm bull tags	30-40 cm wht	40-50 cm rbt	40-50 cm rbt tags	40-50 cm gray	40-50 cm gray tags	40-50 cm bull	40-50 cm bull tags	40-50 cm wht	50-60 cm bull	50-60 cm bull tags	60-70 cm bull	60-70 cm bull tags	total rbt	total gray	total bull	total rb,gr &bull	total wht	total sckr	total sqaw
RS	0	2	0	5	7	0	0	13	12	1y,2r	0	0	0	0	16	0	0	4	1y	0	0	2	0	0	0	0	0	0	0	0	0	0	0	19	6	0	25	36	2	0
RNS	0	0	0	5	1	1	1	13	0	0	4	0	0	0	27	0	0	1	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	1	8	1	10	47	3	0
RM	0	0	0	5	0	2	0	7	0	0	4	0	0	0	5	0	0	1	0	0	0	3	0	0	0	0	0	1	0	0	0	0	0	0	9	1	10	20	0	0
LM	0	0	0	0	0	0	0	2	0	0	1	0	0	0	10	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	13	0	0
LNS	0	3	0	13	0	3	1	7	1	0	5	0	0	0	13	0	0	5	2y	1	0	5	0	0	0	0	0	0	1	0	0	0	0	1	19	2	22	37	7	0
LS	0	0	0	8	15	2	2	26	14	0	1	0	3	1y	18	1	1y	0	0	1	0	20	1	0	2	2y	0	0	0	0	0	0	0	2	0	31	5	8	44	72	2	0
Total	0	5	0	36	23	8	4	63	27		15		3		89	1		10		2		36	1		2		1		3	0		2		52	48	12	112	225	14	0

Note 2 whitefish tags (30 - 40 cm category) (1y)

Swim #2

Lane	0-10 cm rbt	0-10 cm gray	0-10 cm bull	0-10 cm wht	10-20 cm rbt	10-20 cm gray	10-20 cm bull	10-20 cm wht	20-30 cm rbt	20-30 cm rbt tags	20-30 cm gray	20-30 cm gray tags	20-30 cm bull	20-30 cm bull tags	20-30 cm wht	30-40 cm rbt	30-40 cm rbt tags	30-40 cm gray	30-40 cm gray tags	30-40 cm bull	30-40 cm bull tags	30-40 cm wht	40-50 cm rbt	40-50 cm rbt tags	40-50 cm gray	40-50 cm gray tags	40-50 cm bull	40-50 cm bull tags	40-50 cm wht	50-60 cm bull	50-60 cm bull tags	60-70 cm bull	60-70 cm bull tags	total rbt	total gray	total bull	total rb,gr &bull	total wht	total sckr	total sqaw
RS	1	5	0	15	4	7	0	11	8	0	5	0	1	0	18	2	0	2	0		0	6	0	0	0	0	0	0	8	0	0	1	0	15	17	3	35	58	7	0
RNS	0	0	0	4	0	4	1	13	0	0	0	0	0	0	15	0	0	4	1y	1	0	11	2	0	0	0	0	0	0	0	0	0	0	0	8	2	10	43	1	0
RM	0	0	0	0	0	1	0	7	0	0	2	0	0	0	16	0	0	1	0	0	0	13	0	0	0	1	0	0	0	1	0	0	0	0	5	1	6	37	0	0
LM	0	0	0	1	0	1	0	10	0	0	1	0	0	0	11	0	0	1	1y	0	0	5	0	0	0	0	1	0	0	0	0	0	0	0	3	1	4	27	0	0
LNS	0	0	0	5	2	2	0	8	2	1y	2	0	0	0	27	0	0	5	1y,2r	0	0	7	0	0	0	0	0	0	0	0	0	0	0	0	4	9	0	13	47	0	0
LS	1	0	0	9	13	5	0	22	21	1r	8	0	0	0	53	1	1y	8	2y	1	0	1	0	0	0	0	0	1	0	0	0	0	0	0	38	19	3	58	85	0	0
Total	2	5	0	34	19	20	1	71	29		18		1		140	4		19		1		83	1		1		2		9	0		1		55	81	10	126	297	8	0

Note whitefish tag (30 - 50 cm category) (1y)

SUMMARY

Expansion factor = 2.05 × Total mid channel width/mid channel width counted

Expanded Results	0-10 cm rbt	0-10 cm gray	0-10 cm bull	0-10 cm wht	10-20 cm rbt	10-20 cm gray	10-20 cm bull	10-20 cm wht	20-30 cm rbt	20-30 cm gray	20-30 cm bull	20-30 cm wht	30-40 cm rbt	30-40 cm gray	30-40 cm bull	30-40 cm wht	40-50 cm rbt	40-50 cm gray	40-50 cm bull	40-50 cm wht	50-60 cm bull	60-70 cm bull	total rbt	total gray	total bull	total rb,gr &bull	total wht	total sckr	total sqaw
Total for swim 1	0	8	0	60	24	34	6	88	28	30	3	147	1	33	3	51	1	2	2	7	0	2	54	87	16	157	348	25	0
Total for swim 2	2	5	0	45	27	28	2	111	31	21	1	212	4	31	7	81	1	2	1	10	0	1	59	87	14	161	459	9	0
Mean, swim 1&2	1.0	6.6	0.0	52.5	22.6	21.4	4.1	99.6	29.6	25.5	2.0	180	2.5	31.8	5.1	85.3	1.0	2.0	2.6	8.1	0	1.5	57	87	15	159	403	17	0
Standard Error	1.0	1.8	0.0	7.8	2.5	7.1	2.0	11.3	1.5	4.2	1.0	32.9	1.5	1.1	2.0	15.1	0	0.02	0.5	4.0	0	0.5	2.5	0.2	1.0		55.4	7.7	0
Mean,m	0.1	0.9	0.0	7.3	3.1	3.0	0.6	13.8	4.1	3.6	0.3	24.9	0.3	4.4	0.7	9.1	0.1	0.3	0.4	0.6	0	0.2	7.9	12.1	2.1	22.1	56.0	2.3	0
Standard Error	0.14	0.22	0.00	1.09	0.20	0.98	0.28	1.58	0.21	0.59	0.14	4.56	0.21	0.15	0.28	2.09	0.00	0.00	0.07	0.55	0	0.07	0.35	0.03	0.14		7.70	1.07	0
Mean,ha	0.03	0.2	0.0	1.8	0.8	0.7	0.1	3.4	1.0	0.9	0.1	6.1	0.1	1.1	0.2	2.2	0.03	0.1	0.1	0.2	0	0.05	1.9	3.0	0.5	5.4	13.7	0.6	0
Standard Error	0.03	0.05	0.00	0.27	0.05	0.24	0.07	0.39	0.05	0.14	0.03	1.12	0.05	0.04	0.01	0.51	0.00	0.00	0.02	0.14	0	0.02	0.09	0.01	0.03		1.89	0.26	0

Equal or > 20 cm					
total rbt	total gray	total bull	total rb,gr &bull	total wht	total sckr
30	64	10	104	200	
36	54	12	102	301	
33	59	11	103	251	
3.0	5.3	1.0		52	
4.8	9.2	1.5	14.3	35	
0.4	0.7	0.1		7.2	
1.1	2.0	0.4	3.5	8.6	
0.10	0.18	0.03		1.8	

- total count for each swim was obtained by expanding the mid-lane count (lanes RNS, RM, LM, and LNS) x exp. factor, and adding the shore lane (RS, LS) counts
- bull char. and squawfish counts are restricted to individuals equal and more than 20 cm in length
- a table is included (lower right side) with total rainbow trout, arctic grayling and bull trout equal and more than 20 cm in order to compare the swim counts with mark-recapture estimates

RS - Right shore
RNS - Right near shore
RM - Right midchannel
LM - Left midchannel
LNS - Left near shore
LS - Left shore
rbt, rb or r - rainbow trout
gray or gr - grayling
bull or b - bull trout
wht - mountain whitefish
sckr - sucker species
sqaw - squawfish

Table A17. Mesilinka River swim counts, Reach 12, 1993

Mesilinka River Swim Count 1993 — Reach 12

Visibility 4 m — Length of Reach = 8.1 km — Ave. width = 38.7 m — Area = 31.3 ha — # Swimmers = 6 — Date swim 1: Aug 19, 93 — Date swim 2: Aug 19, 93

Swim #1

Lane	0-10 cm rbt	0-10 cm gray	0-10 cm bull	0-10 cm wht	10-20 cm rbt	10-20 cm gray	10-20 cm bull	10-20 cm wht	20-30 cm rbt	20-30 cm rbt tags	20-30 cm gray	20-30 cm gray tags	20-30 cm bull	20-30 cm bull tags	20-30 cm wht	30-40 cm rbt	30-40 cm rbt tags	30-40 cm gray	30-40 cm gray tags	30-40 cm bull	30-40 cm bull tags	30-40 cm wht	40-50 cm rbt	40-50 cm rbt tags	40-50 cm gray	40-50 cm gray tags	40-50 cm bull	40-50 cm bull tags	40-50 cm wht	50-60 cm bull	50-60 cm bull tags	60-70 cm bull	60-70 cm bull tags	total rbt	total gray	total bull	total rb,gr &bull	total wht	total ackr	total sqaw
RS	2	0	0	24	23	1	0	7	17	1w	4	1w	0	0	14	10	1w,1z	3	1y	1	0	5	0	0	0	0	2	0	1	1	0	0	0	52	8	4	64	51	3	0
RNS	0	0	0	7	0	0	0	11	0	0	1	0	1	0	14	0	0	0	0	1	0	7	1	0	0	0	1	0	0	0	0	2	0	1	1	5	7	39	4	0
RM	0	0	1	4	2	3	0	10	8	1w	0	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	1w	0	0	10	3	3	16	19	28	0
LM	0	0	0	0	1	0	0	8	3	0	2	0	1	0	5	0	0	0	0	0	0	5	0	0	0	0	0	1	0	0	0	0	0	4	2	3	9	22	5	4
LNS	0	0	0	14	1	1	0	13	1	0	2	0	2	0	10	1	0	2	1y	1	1w	1	0	0	0	0	0	0	0	1	1w	0	0	3	5	5	13	40	4	0
LS	0	0	0	10	4	1	0	10	5	0	4	0	0	0	10	4	0	2	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	13	7	0	20	31	9	0
Total	2	0	1	59	31	6	0	59	34		13		4		61	15		7		2		22	1		0		5		1	2		3		83	28	20	129	202	51	4

Swim #2

Lane	0-10 cm rbt	0-10 cm gray	0-10 cm bull	0-10 cm wht	10-20 cm rbt	10-20 cm gray	10-20 cm bull	10-20 cm wht	20-30 cm rbt	20-30 cm rbt tags	20-30 cm gray	20-30 cm gray tags	20-30 cm bull	20-30 cm bull tags	20-30 cm wht	30-40 cm rbt	30-40 cm rbt tags	30-40 cm gray	30-40 cm gray tags	30-40 cm bull	30-40 cm bull tags	30-40 cm wht	40-50 cm rbt	40-50 cm rbt tags	40-50 cm gray	40-50 cm gray tags	40-50 cm bull	40-50 cm bull tags	40-50 cm wht	50-60 cm bull	50-60 cm bull tags	60-70 cm bull	60-70 cm bull tags	total rbt	total gray	total bull	total rb,gr &bull	total wht	total ackr	total sqaw
RS	1	1	0	16	26	4	2	17	34	1w	9	0	3	0	28	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	62	14	8	84	61	10	0
RNS	0	1	0	19	4	3	0	10	4	1y	7	0	2	1g	11	2	0	1	1y	1	0	3	0	0	0	0	0	1	0	0	1	1w	1	1w	8	12	10	31	43	6	0
RM	0	1	0	1	0	1	0	10	1	0	2	0	0	0	17	0	0	0	0	1	0	3	0	0	0	0	0	1	0	0	0	0	0	0	1	4	2	7	31	2	0
LM	0	0	0	18	1	4	0	20	0	0	0	0	0	0	13	0	0	0	0	1	0	4	0	0	0	0	0	1	0	1	1	0	0	0	1	4	3	8	56	4	0
LNS	0	0	0	15	3	1	0	8	11	3w	3	0	0	0	13	3	0	2	0	1	0	4	0	0	0	0	0	0	0	0	0	0	2	0	17	8	3	28	40	5	0
LS	0	0	0	8	6	1	0	9	14	1w	4	0	0	0	17	4	1w,1x	0	0	0	0	3	0	0	0	0	2	1w	1	0	0	0	0	24	5	2	31	38	11	3
Total	1	3	0	77	39	14	2	74	64		25		5		99	10		3		3		17	0		0		5		2	2		3		114	45	28	187	269	37	3

SUMMARY

Expansion factor = 1.92 = Total mid channel width/mid channel width counted

Expanded Results	0-10 cm rbt	0-10 cm gray	0-10 cm bull	0-10 cm wht	10-20 cm rbt	10-20 cm gray	10-20 cm bull	10-20 cm wht	20-30 cm rbt	20-30 cm gray	20-30 cm bull	20-30 cm wht	30-40 cm rbt	30-40 cm gray	30-40 cm bull	30-40 cm wht	40-50 cm rbt	40-50 cm gray	40-50 cm bull	40-50 cm wht	50-60 cm bull	60-70 cm bull	total rbt	total gray	total bull	total rb,gr &bull	total wht	total ackr	total sqaw
Total for swim 1	2	0	2	82	35	10	0	98	45	18	8	95	18	9	9	37	1	0	4	1	3	6	100	36	35	170	312	87	8
Total for swim 2	1	5	0	126	45	22	2	118	79	38	7	149	15	6	18	30	1	0	3	3	4	6	140	69	45	253	425	52	3
Mean, swim 1&2	1.5	2.4	1.0	104	40.1	16.0	1.0	108	61.9	28.8	7.3	122	15.3	7.3	13.5	33.3	1.0	0.0	1.6	2.0	3.4	5.8	120	52	40	212	369	69	5
Standard Error	0.5	2.4	1.0	21.9	5.4	6.3	1.0	10.3	16.8	9.2	0.4	26.8	0.7	1.5	4.8	3.4	0.0	0.0	0.0	1.0	0.5	0.0	20.1	16.4	4.92		56.5	17.6	2.3
Maximum	0.2	0.3	0.1	12.8	4.9	2.0	0.1	13.3	7.6	3.3	0.9	15.0	1.9	0.9	1.7	4.1	0.1	0.0	0.2	0.2	0.4	0.7	14.8	6.5	4.9	26.1	45.5	8.6	0.7
Standard Error	0.08	0.30	0.12	2.20	0.68	0.78	0.12	1.27	2.08	1.14	0.05	3.31	0.08	0.19	0.60	0.42	0.12	0.00	0.00	0.12	0.06	0.00	2.48	2.02	0.61		6.97	2.17	0.29
Mesilinka	0.05	0.08	0.03	3.3	1.3	0.5	0.03	3.4	2.0	0.9	0.2	3.9	0.5	0.2	0.4	1.1	0.03	0.0	0.2	0.1	0.1	0.2	3.8	1.7	1.3	6.8	11.8	2.2	0.2
Standard Error	0.02	0.08	0.03	0.70	0.17	0.29	0.03	0.33	0.54	0.29	0.01	0.86	0.02	0.05	0.15	0.11	0.01	0.00	0.00	0.03	0.01	0.00	0.64	0.52	0.16		1.80	0.56	0.07

Equal or > 20 cm	total rbt	total gray	total bull	total rb,gr	total wht
	63	28	33	122	133
	93	42	43	178	181
	78	34	38	150	157
	15.2	7.7	4.8		24
	9.6	4.2	4.6	18.4	19
	1.9	1.0	0.6		3
	2.5	1.1	1.2	4.8	5.0
	0.49	0.24	0.16		0.8

- Total count for each swim was obtained by expanding the mid lane count (sum RNS, RM, LM, and LNS x exp. factor) and adding the shore lane (RS, LS) counts.
- Jacker and equivalent counts are restricted to individuals equal and more than 20 cm in length.
- x refers to marked lower right side with total rainbow trout, arctic grayling and bull trout equal and more than 20 cm counts to calculate the swim counts with mark recapture estimates.

RS - Right shore; RNS - Right near shore; RM - Right mid channel; LM - Left mid channel; LNS - Left near shore; LS - Left shore; rbt - rainbow trout; gray - grayling; bull - bull trout; wht - mountain whitefish; ackr - Arctic lamprey; sqaw - squawfish